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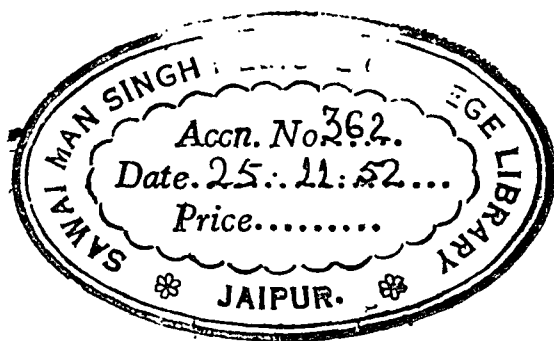
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No. 1

## RECENT DEVELOPMENTS IN MEDICAL PHYSICS HAVING APPLICATION TO RADIATION THERAPY\*

By HARDIN B. JONES, Ph.D.

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**I**N SURVEYING recent developments in medical physics that possibly have application in radiation therapy, I have nothing spectacular to review, nothing of any immediate issue in radiation therapy.

I would like merely to spin a tale of work which is currently being done in some of the laboratories in the country, some in our own laboratory, all of which will have application to the general field of radiation therapy.

Much of the work in radiation therapy hinges around the use of radiation of radioactive isotopes. They are useful in two ways: (1) by specific localization of radioactive material, and (2) as tools for the study of metabolism. There are already certain radioactive compounds which can be made to accumulate only in certain normal tissues, and their radiation is expended where the radioactive substance is located. So far specific localization has been possible only for normal tissues but it is possible that, similarly, neoplastic tissue might specifically absorb certain compounds.

As yet there have been discovered no

substances with true specific localization in neoplastic tissue. Radioactive phosphorus has been generally used to give local and general radiation therapy. When radioactive phosphate is administered the phosphate is slightly concentrated in neoplastic tissue but it is generally distributed in the whole body, and the most we could hope for as a concentration of the radioactive phosphate would be approximately twice as much in the neoplastic as in the normal tissues.

Besides phosphorus, strontium has been used, but here again no specific localization has been found in neoplastic tissues. An excellent example of a specifically localizing radioactive isotope is radioactive iodine. The normal thyroid gland certainly concentrates radioactive iodine if it is administered in small amounts. This method has been used successfully to irradiate the thyroid, and this form of specific irradiation depresses the activity of the hyperactive thyroid gland; but, as far as approaching the ultimate goal in the use of isotopes—that we might be able to find a substance that would localize in neoplastic tissue to a

\* Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

great extent—that goal has not been achieved.

However, the results of recent investigation are promising. In certain instances we are able to localize in other tissues specific amounts of these artificial radioactive isotopes. Chromic phosphate when administered intravenously will go to the normal liver and spleen in about equal concentrations. This is an ideal situation for studying the specific effect of radiation upon these two tissues. Again we have little use of chromic phosphate for applying radiation therapy to these organs invaded by neoplastic disease. In neoplastic diseases of the liver, the chromic phosphate concentrates only in the normal liver tissue. Irradiation of neoplastic tissue is at the expense of irradiation of the normal tissue.

We anticipate the development of compounds which will localize in a given neoplasm. Chromic phosphate can be used experimentally to give local radiation of tissues if it is not introduced by infusion of the tissues. We hope to develop work along this line to find out factors which will help to make for uniform spreading of this inert radioactive compound through the tissues so that localized areas can be specifically irradiated. So far we have been unable to develop a compound which will do anything but stay at the exact site where the needle introduced it into the tissues. It is not impossible to look forward into the future when we will be able to say we have a compound which will spread uniformly through the tissues. This would be useful for selective irradiation of skin, subcutaneous tissue, and lymphatic tissue.

A method that is promising is to find some compound which through a phase of physiological chemistry might become built into the neoplastic tissue preferentially. Such a substance might be synthesized with radiocarbon, radiohydrogen, radiohalogens, or radiophosphorus. It is not hopeless to think perhaps that some precursor of nucleic acid or even some simple substance such as an amino acid might be taken up with great selectivity by neoplastic tissue

and not by the rest of the body. A disease such as melanoma should be amenable to this research. With the existing knowledge of melanin chemistry it should be possible to build radioactive carbon into precursors of melanin which is formed in great quantities by the neoplasm. The melanoma would thus be given specific localized radiation from the contained radioactive carbon.

A great deal of work by Hevesy on nucleic acid metabolism appeared during the war which is of extreme interest. He has shown that in the case of two neoplasms growing in the same animal if one of the tumors is irradiated with roentgen rays and the rest of the animal not irradiated, that simultaneously after the irradiation, there is a decrease in the nucleic acid turnover in the irradiated tumor and the non-irradiated tumor. The non-irradiated tumor received no direct irradiation, but depression of nucleic acid synthesis is striking and could only have been mediated by a chemical substance moving from the irradiated tumor into the blood. This substance depresses nucleic acid metabolism either of the animal as a whole or of the other tumor specifically. Such an indirect effect of irradiation gives us hope that perhaps the neoplastic growth inhibiting mechanism associated with tissue irradiation is a chemical substance and is not due to tissue ionization directly. It should be possible to localize and identify such a compound, and it is reasonably likely that it can be used therapeutically when found. Perhaps future radiation treatment will be by the use of such a chemical compound and not by the direct irradiation of the tissue.

There is some work now in the experimental stage to develop new forms of applying radiation therapy. The betatron, as is well known, for the past several years has been able to develop 20 million volt gamma rays and beta rays which are available for radiation therapy. The advantage of such high energy particle gamma rays is that the maximum ionization is not at the body surface at the point of entry of the radia-

tion beam. On the contrary, the ionization increases progressively beyond the surface. In the case of beta radiation from the betatron of 20 million volts energy, one can irradiate tissues as deep as 12 centimeters to an extent of twice the skin dosage. This tissue depth dose is quite different from the conventional type of roentgen therapy or million volt roentgen therapy.

Now if we are interested in the betatron, we probably would also be interested in the other advances that are currently going on in the general field of physics. There are not only betatrons producing high energy particles, but there are particle accelerating machines (cyclotrons, cyclo sychotrons, linear accelerators, etc.) which will produce very high energy beta, alpha, proton, and deuteron particles. There is an indication of a future tendency in radiation therapy that accelerated protons of the 100 million volt magnitude are even more promising for certain types of tissue irradiation than accelerated electrons.

Dr. Wilson of Harvard University expects to be able to demonstrate that the dosage ratio of the surface of the skin compared to the deeper tissues might be as high as one hundred to one in favor of the radiation of deeper tissues. This, of course, would not necessarily revolutionize common roentgen therapy, but it would make

available to the roentgenologist a new tool which would give an especially well localized irradiation of deeper tissues when such is a desired therapy.

We have reason to hope in the future for the finding of substances which, either by metabolic sequences or by physical properties, can be localized in certain neoplasms so that neoplastic diseases may be treated by self-contained radiation. However, these goals have not been realized. We do feel that if we really understood the biology of neoplastic disease methods other than tissue irradiation might be developed which would be more effective. We believe the best hope for cancer control is with the use of radioactive isotopes because their powerful use as tracers and dynameters of metabolic processes will result in a working understanding of normal and neoplastic metabolic processes. Only when we have accumulated more knowledge of metabolism can effective ways be found to eradicate neoplastic disease by methods other than by radiation therapy and surgery.\*

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\* For discussion see page 30.





# RADIOACTIVE PHOSPHORUS AS AN EXTERNAL THERAPEUTIC AGENT IN BASAL CELL CARCINOMA, WARTS AND HEMANGIOMA\*

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SINCE the discovery of natural radioactivity and the recognition of cathode rays as high speed beta particles, attempts have repeatedly been made to utilize beta radiation in the treatment of skin diseases. It has long been appreciated that beta radiation is particularly suitable for the treatment of superficial lesions of the skin, because beta rays penetrate the skin to a depth of only a few millimeters, thus reaching all layers of the skin without penetrating to deeper structures. It is also known that the general biological effect of beta rays is similar to that of other ionizing radiations such as roentgen rays or gamma rays; that is, when beta rays are applied in sufficient quantity they are capable of destroying living cells. Until the discovery of artificial radioactivity, available sources of beta radiation were either naturally occurring radioactive substances or specially constructed cathode-ray tubes. Neither of these sources, however, provides pure beta radiation. The lag in the development and establishment of beta radiation therapy has been due in large part to this fact, although the complex problem of dosage, and the primary interest in the therapeutic use of gamma rays have contributed to delaying progress in this field. The discovery of artificial radioactivity has made available substances which radiate beta particles only. Radioactive phosphorus ( $P^{32}$ ) is one such substance.  $P^{32}$  disintegrates at a daily rate of 4.8 per cent and thus loses one-half of its initial activity in 14.3 days. The maximum penetration of  $P^{32}$  beta particles in water or tissue is approximately 8 mm. One must realize, however, that the energy of the  $P^{32}$  beta particles varies from 0 electron

volts to  $1.69 \times 10^6$  e.v.; therefore only a relatively small percentage actually penetrates to the 8 mm. depth. Absorption measurements have shown that approximately 48 per cent of the radiation from  $P^{32}$  is absorbed in the first millimeter of water or tissue and that the absorption is practically exponential. The radioactive phosphorus which has been used in these studies is an aqueous solution of disodium hydrogen phosphate containing 15 mg. of the salt per cubic centimeter of water.

The present studies were started in 1941 and after an interruption of one year were resumed in 1943. Despite the obvious possibilities of using  $P^{32}$  solution for external application to the skin, difficulties were encountered in developing a technique which would insure exactly reproducible exposures and reactions. After experimentation with absorbent cotton, vaseline, lanolin, blotting paper, gum acacia, higher alcohols and other substances, it was found that ordinary thin blotting paper is a most suitable vehicle. Blotting paper of known dimensions soaked in measured amounts of radioactive  $Na_2HPO_4$  solution, and dried, can be

TABLE I

Degree of Reaction	Microcuries per sq. cm.
Threshold erythema	34
Mild erythema	approx. 620
Marked erythema	approx. 1250
Severe erythema	approx. 1850
Mild epidermitis (dry, scaly)	approx. 2500
Marked epidermitis (scaly or bullous)	approx. 3200
Severe epidermitis (epidermolysis)	approx. 4400

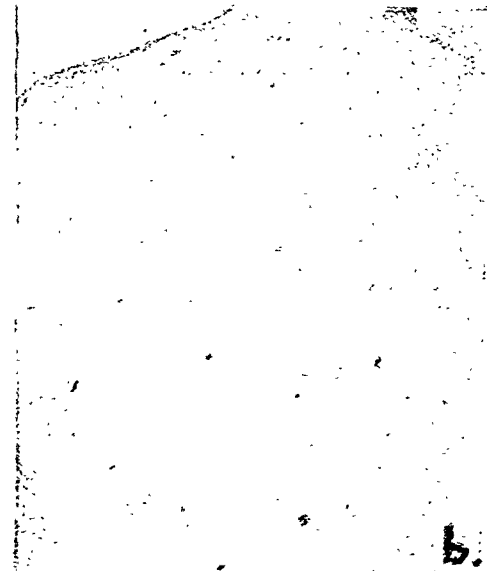
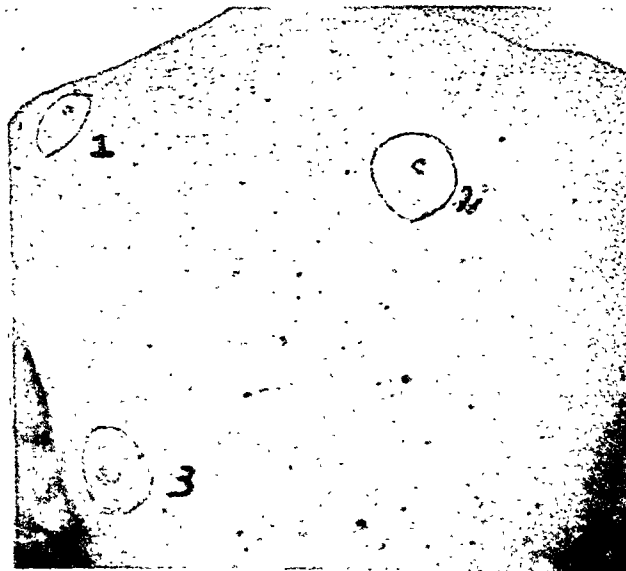
\* Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

FIG. 1. G.B. Basal cell epithelioma, right side of the face. (a) Before treatment. (b) One year after four treatments. One of the earliest cases treated (in March, 1943). Total dose of radioactive phosphorus approximately 9,000 microcurie-hours. No recurrence and no further skin changes for three years.



FIG. 2. J.D.B. Basal cell epithelioma, left side of the face and forehead (intradermal). (a) Before treatment. (b) Seven months after two treatments. Dose of radioactive phosphorus 6,600 microcurie-hours per square centimeter.

FIG. 3. H.H.B. Multiple basal cell carcinoma and hyperkeratoses. (a) Before treatment. (b) Forty-five days after treatment. Lesions 1 and 2, 2,000 microcurie-hours per square centimeter; lesion 3, 2,600 microcurie-hours per square centimeter. Treated April, 1944. No recurrence.



applied easily to any part of the skin. The following method of application has been developed: Office type blotting paper 0.4 mm. thick and weighing 21 mg. per square centimeter is cut to size to cover the lesion and to allow a safety margin from 0.3 to 1.0 cm., depending upon the type of lesion.

The blotting paper is backed by some kind of adhesive tape, and placed on a good drying surface such as a radiator or electric plate at low heat. A measured amount of  $P^{32}$  solution is then soaked into the blotting paper which is left to dry. When completely prepared, the blotting paper is applied over

TABLE II-A  
INITIAL MICROCURIES REQUIRED FOR VARYING DEGREES OF ERYTHEMA  
Exposure Time: 24 Hours

Reaction	Area in Square Centimeters									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Mild erythema	12.3	24.5	36.8	49	61.3	73.5	85.8	98	110	123
Moderately intense erythema	24.5	49	73.5	98	123	147	172	196	221	245
Severe erythema	36.8	73.5	110	147	184	221	257	294	331	368
Mild epidermitis (dry, scaly)	49	98	147	196	245	294	343	392	441	490
Moderately intense epidermitis (scaly or wet)	61.3	123	184	245	306	368	429	490	551	613
Severe epidermitis (bullous epidermolysis)	85.8	172	257	343	429	515	600	686	772	858

Exposure Time: 48 Hours

Reaction	Area in Square Centimeters									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Mild erythema	6.5	12.9	19.4	25.8	32.3	38.7	45.2	51.6	58.1	64.5
Moderately intense erythema	12.9	25.8	38.7	51.6	64.5	77.4	90.3	103	116	129
Severe erythema	19.4	38.7	58.1	77.4	96.7	116	135	155	174	193
Mild epidermitis (dry, scaly)	25.8	51.6	77.4	103	129	155	181	206	232	258
Moderately intense epidermitis (scaly or wet)	32.3	64.5	96.7	129	161	194	226	258	290	323
Severe epidermitis (bullous epidermolysis)	45.2	90.3	135	181	226	271	316	361	406	451

TABLE II-B  
INITIAL MICROCURIES REQUIRED FOR VARYING DEGREES OF ERYTHEMA  
Exposure Time: 72 Hours

Reaction	Area in Square Centimeters									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Mild erythema	4.6	9.1	13.7	18.2	22.8	27.3	31.8	36.4	41.0	45.5
Moderately intense erythema	9.1	18.2	27.3	36.4	45.5	54.6	63.7	72.8	81.9	91.0
Severe erythema	13.6	27.3	41.0	54.6	68.3	81.9	95.8	109.	123	137
Mild epidermitis (dry, scaly)	18.2	36.4	54.6	72.8	91.0	109	127	146	164	182
Moderately intense epidermitis (scaly or wet)	22.8	45.5	68.3	91.0	114	137	159	182	205	228
Severe epidermitis (bullous epidermolysis)	31.9	63.7	95.6	127	159	191	223	255	286	319

Exposure Time: 96 Hours

Reaction	Area in Square Centimeters									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Mild erythema	3.6	7.1	10.7	14.3	17.8	21.4	25	28.5	32.1	35.7
Moderately intense erythema	7.1	14.3	21.4	28.6	35.7	42.8	50	57.1	64.3	71.4
Severe erythema	10.7	21.4	32.1	42.8	53.6	64.3	75	85.7	96.4	107
Mild epidermitis (dry, scaly)	14.3	28.6	42.8	57.2	71.4	85.7	100	114	128	143
Moderately intense epidermitis (scaly or wet)	17.8	35.7	53.5	71.4	89.1	107	125	143	162	178
Severe epidermitis (bullous epidermolysis)	25	50	75	100	125	150	175	200	225	250

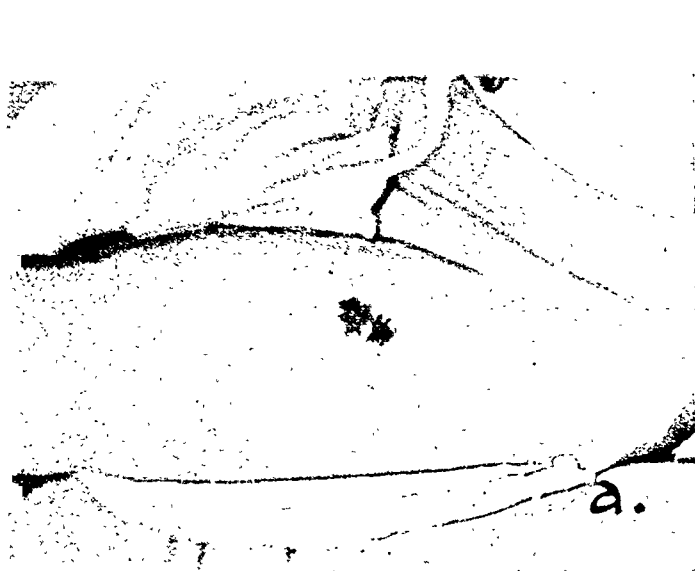


FIG. 4. H.C. Hemangioma, right thigh. (a) Before treatment. (b) Seven months after treatment. First and second treatments were ten weeks apart. Second and third treatments were six weeks apart. Each treatment approximately 200 microcurie-hours per square centimeter.



FIG. 5. S.J.St. Basal cell carcinoma on right side of neck (a) Before treatment. (b) Eleven days after beginning of treatment. Dose, 4,300 microcurie-hours per square centimeter. (c) Sixty days after beginning of treatment. No recurrence and no further skin changes for two and one-half years.

the skin lesion to be treated and secured in place if necessary with additional adhesive tape. It is left in place for a sufficient time to provide the desirable exposure for the condition under treatment. The exposure is calculated in microcurie-hours per square centimeter, since the reaction obtained will be a function of the area over which radiation is distributed and of the time of exposure. Once a technique had been established, the first question to consider was the

evidently a function of the area over which the  $P^{32}$  is distributed, and of the time of exposure. Accordingly, it has been possible to compute the amounts of  $P^{32}$  required to produce certain reactions.

With the foregoing experimental data on hand therapeutic studies were undertaken. During the period from March, 1943, to October, 1945, 301 skin lesions were treated by external local application of  $P^{32}$ . Since October, 1945, some 100 additional

TABLE III  
TREATMENT STATISTICS

Type of Lesion	Number of Lesions	Number of Treatments Required					Reurrence	No Conclusion. Patient Did not Return	Lesion Disappeared	Percentage of Lesions Disappeared
		1	2	3	4	5				
Basal cell carcinoma <sup>1</sup>	52	46	4	1*	1		1		51	98.0
Hyperkeratosis <sup>2</sup>	36	36							36	100
Verruca, hands <sup>3</sup>	132	104	13				6	9	117	88.6
Plantar wart <sup>4</sup>	50	44	3				2	1	47	94.0
Subungual wart <sup>5</sup>	16	12	3				1		15	93.6
Hemangioma <sup>6</sup>	17	3	2	4	4	2			2	

\* Within two months.

<sup>1</sup> Three lesions were recurrences after curettement and desiccation; two lesions were recurrences after treatment with roentgen rays.

<sup>2</sup> One lesion was a recurrence after treatment with roentgen rays.

<sup>3</sup> Three lesions were recurrences after treatment with roentgen rays; one lesion a recurrence after treatment with acid.

<sup>4</sup> Two lesions were recurrences after surgery; two lesions were recurrences after treatment with roentgen rays.

<sup>5</sup> One lesion was a recurrence after treatment with roentgen rays.

<sup>6</sup> Two lesions disappeared (1944); fifteen lesions improved, still under observation.

development of erythema as a biological measure of the effect of  $P^{32}$  beta radiation on the skin. It was found that the minimum exposure which produces a faint but discernible "threshold" erythema is 34 microcurie-hours per square centimeter. Subsequent studies have shown that the intensity of the skin reaction increases with the exposure.

Erythema studies carried out on 12 subjects with a total of 61 exposures were studied.<sup>1</sup>

Prior to the clinical erythema studies it was experimentally proved that the distribution of  $P^{32}$  solution in blotting paper of the sizes used in the studies is uniform. As stated before, when the distribution is uniform the radiation dose delivered is

lesions have been treated but these are omitted from the present report because of the shortness of the observation period.

Table III shows the various types of lesions treated, and the outcome of treatment.

Figures 1 to 5 show some of the patients before and after treatment.

All patients with hyperkeratosis or carcinoma were seen by at least two members of the Visible Tumor Clinic of the University of California Hospital. In all cases of carcinoma there was unanimous opinion as to diagnosis. Biopsy was taken in most instances. When a patient had multiple lesions, biopsy was taken usually from only one lesion. The diagnosis of hyperkeratosis was based on clinical judgment alone, and it

TABLE IV  
TREATMENT PLAN

Lesion	Dosage	Lesion	Dosage
Warty basal cell carcinoma with pearly margins	5000 microcurie-hours per sq. cm. at <i>least</i> 0.5 cm. safety margin	Verruca vulgaris*	2500-4000 microcurie-hours per sq. cm.
Flat, scaly basal cell carcinoma	3500-4500 microcurie-hours per sq. cm. at least 1 cm. safety margin	Verruca plantaris†	3000-4500 microcurie-hours per sq. cm. depending on depth
Flat hyperkeratosis	3500-4000 microcurie-hours per sq. cm. 0.5 cm. safety margin	Subungual verruca**	4000-5000 microcurie-hours per sq. cm.
Warty hyperkeratosis	3000-4000 microcurie-hours per sq. cm. 0.3-0.5 cm. safety margin; repeat if necessary in 8 weeks	Hemangioma‡	300-600 microcurie-hours per sq. cm.

\* Scrape off horny surface before treatment with P<sup>32</sup>.

† Wide range of dosage due to variation in depth of lesion. If one treatment without success within 6 weeks, then repeat treatment after scraping off surface thoroughly.

\*\* Nail should be cut as short as possible before P<sup>32</sup> pad is applied.

‡ Repeat in monthly intervals depending on response.

is possible that some of these lesions were early malignancies.

During the early stages of these studies, dosage of the radioactive phosphorus varied considerably among the cases treated. Observation of the reactions, and analysis of the different doses in relation to the therapeutic response has led to a pattern of dosage which is now being systematically employed (Table IV). This has completely supplanted the empiricism with regard to dosage of the earlier stages of this study.

One more word concerning dosage. One must be aware of the inadequacy of expressing the dose by giving the amount of the radiating source and the time of exposure. At present, however, this seems to be the least confusing and misleading dosage determination. The ultimate aim is to express the dose in some unit which will reveal more about the energy dissipated in the tissues. The applicability of the unit "roentgen" to energy dissipated from beta radiation is debatable. Should existing questions be resolved in favor of using the "roentgen," it should be qualified by employing the term "beta roentgen" in order to indicate that the energy dissipated is

derived from a beta radiating source.

The purpose of this report is to demonstrate that artificially radioactivated phosphorus, as a pure beta radiator, can be used satisfactorily in the treatment of superficial skin diseases. It is true that there are other well established methods of treatment of skin diseases which have proved satisfactory, such as low kilovoltage roentgen rays, surface surgery, etc. Certainly there is no intention to advance the method described in this report in competition with such long established procedures.

Rather, the present study has served to emphasize the usefulness in a particular field of therapeutics of one of the many bi-products of the chain reacting piles established for the production of plutonium and uranium 235.\*

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\* For discussion see page 30.

# THE DEPOSITION OF RADIOACTIVE METALS IN BONE AS A POTENTIAL HEALTH HAZARD\*†

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THE radioactive elements involved in nuclear fission present a danger to those working in production plants and laboratories handling this material. Many of these elements are deposited in the skeleton where they constitute a hazard quite similar to that of chronic radium poisoning. During the 1920's several hundred persons died from the effects of radium exposure. Many of these individuals had worked in the luminous dial plants in World War I. The effects of chronic radium poisoning, which include osteomyelitis, bone necrosis and osteogenic sarcoma, were referable to the chronic radiations from minute doses of radium which had been deposited in the skeleton. When a nuclear chain reaction pile became a probability, it was recognized that the amounts of radioactive materials involved would be many million times greater than anything encountered in the radium industry.

In general, the radioactive isotopes produced in the fission process have short half-lives, so that radioactive decay quickly reduces their concentration. However, certain isotopes, including those of strontium, yttrium, cerium, and plutonium, have such long half-lives that they would present a serious hazard of chronic radiation toxicity should an individual become contaminated. These elements are rapidly fixed in the skeleton, and are eliminated at a very slow rate. The localization of these elements in the skeleton exposes the sensitive cells of the bone and bone marrow to toxic radia-

tions, with the resulting danger of bone marrow destruction, bone necrosis and bone tumors.

The metabolism of bone was investigated to determine the factors concerned in the absorption and deposition of these elements in the skeleton and the precise sites of localization. The chronic elimination of these radioactive materials was studied in rats, and the effects of the standard procedures used in treating chronic radium poisoning were compared. Finally, a possible mechanism for reducing the toxicity of the plutonium deposits in the bone was investigated.

The first element studied was radioactive strontium ( $\text{Sr}^*$ ). This alkaline earth closely resembles calcium in behavior<sup>1</sup> and thus serves as an indicator for calcification activity and calcium metabolism. It was the only element in the group to be absorbed to any significant extent from the intestinal tract, and so presented a potential danger from contaminated food or water.

Only two factors were found to have a marked effect on the absorption of  $\text{Sr}^*$  from the gut. These were: (1) the age of the animals, and (2) the adequacy of calcium in the diet (Table I).

When a given dose of  $\text{Sr}^*$  was fed to young, growing rats on a diet low in calcium the skeletal retention was almost twenty-five times as great as that of adult rats on a

\* The symbols  $\text{Sr}^*$ ,  $\text{Y}^*$ ,  $\text{Ce}^*$ , or  $\text{Pu}^*$  indicate the respective element "labelled" by its content of radioactive isotope.

\* This document is based on work performed under Contract No. W-7405-eng-48-A for the Manhattan Project, and the information covered in this document will appear in Division IV of the Manhattan Project Technical Series, as part of the contribution of the Radiation Laboratory, University of California.

† Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

high calcium diet (Table I). Although not so marked, the same general effect was noted (Table II) when the  $\text{Sr}^*$  was injected intraperitoneally; young calcium deficient rats retained almost four times as much  $\text{Sr}^*$  in the skeleton as did adult animals on a

In contrast to strontium, no significant difference in the behavior of plutonium, yttrium, or cerium was observed when these same two groups of animals were compared (Table II).

Another condition which profoundly in-

TABLE I  
EFFECT OF SKELETAL GROWTH AND CALCIUM INTAKE ON THE  
ABSORPTION OF  $\text{Sr}^*$  FROM THE GUT

Age	Diet (2 months)	Per Cent of Dose of $\text{Sr}^*$ in		
		Carcass	Feces	Urine
Young, growing	Low calcium	73.1	20.9	2.7
Young, growing	High calcium	17.1	58.8	13.3
Old, adult	Low calcium	15.7	69.9	8.4
Old, adult	High calcium	2.8	81.8	8.3

(Figures given are the averages for the 5 animals in each group.)

TABLE II  
EFFECT OF AGE AND CALCIUM DEFICIENCY ON  $\text{Sr}^*$ ,  $\text{Pu}^*$ ,  $\text{Y}^*$ , AND  $\text{Ce}^*$

Element	Age	Diet	Per Cent of Dose Absorbed	Per Cent of Absorbed Dose in			
				Carcass	Urine	Feces	Liver
$\text{Sr}^*$	Young	Ca deficient	100	70.3	1.8	22.0	
	Old	High calcium	100	14.1	41.7	29.2	
$\text{Pu}^*$	Young	Ca deficient	46.0	71.4	3.3	6.5	10.4
	Old	High calcium	48.9	63.2	4.3	13.5	12.9
$\text{Y}^*$	Young	Ca deficient	77.0	80.9	7.2	7.6	4.3
	Old	High calcium	77.4	77.1	14.3	5.2	3.4
$\text{Ce}^*$	Young	Ca deficient	89.2	51.8	1.1	7.1	40.0
	Old	High calcium	85.5	34.4	9.8	17.2	38.6

(The figures given are average values for each group of 5 rats.  $\text{Sr}^*$  was injected intraperitoneally,  $\text{Pu}^*$ ,  $\text{Ce}^*$ ,  $\text{Y}^*$ , intramuscularly.)

high calcium diet, reflecting the increased calcification activity in the former.

These results indicate an increased hazard from radioactive strontium, and presumably radium, to young, growing individuals and to those on a low calcium diet. Accordingly, work involving exposure to radio-strontium or radium should be restricted to adults, and care should be taken to maintain a high level of calcium intake in these individuals.

fluences bone metabolism is severe phosphorus deficiency, first reported in rats by Day and McCollum<sup>2</sup> in 1939. When young rats were placed on a diet containing less than 0.01 per cent phosphorus, severe deficiency signs appeared within two weeks including marked demineralization of the skeleton. The bones contained only one-fourth of the bone salt present in the skeleton of normal control rats. It has been suggested that this demineralization is due



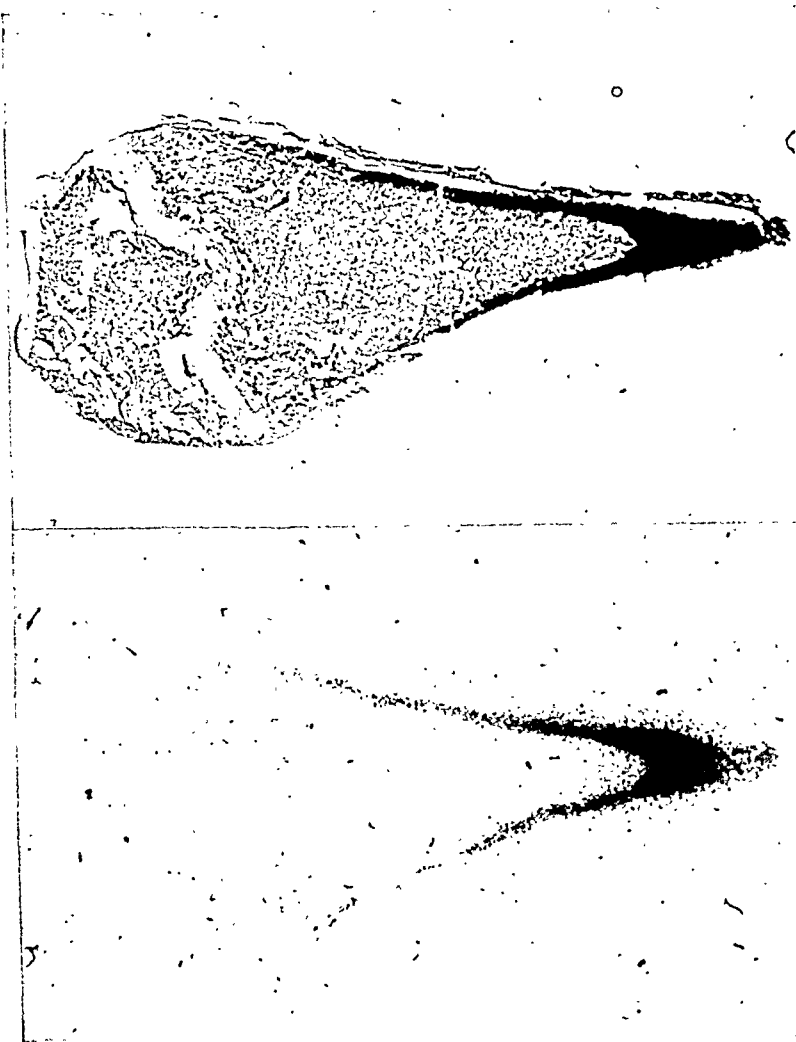


FIG. 1. Femur from rat weaned to phosphorus deficient diet at three weeks, injected intraperitoneally with 5 microcuries of strontium at five weeks, and sacrificed one week later. Note that the strontium is deposited almost exclusively in the bone salt of the shaft, with practically none in the uncalcified steoid matrix below the epiphysis. (Hematoxylin, eosin, and silver nitrate) ( $\times 13$ ).

TABLE III  
EFFECT OF PHOSPHORUS DEFICIENCY ON RETENTION  
OF  $\text{Sr}^*$ ,  $\text{Pu}^*$ ,  $\text{Y}^*$ , AND  $\text{Ce}^*$

Element	Diet	Per Cent of Dose Absorbed	Per Cent of Absorbed Dose in		
			Car- cass	Urine	Feces
$\text{Sr}^*$	Control	100	76.3	5.6	8.3
	P deficient	100	25.8	36.5	12.7
$\text{Pu}^*$	Control	30.3	80.1	2.8	6.0
	P deficient	58.0	83.9	3.7	6.8
$\text{Y}^*$	Control	57.9	75.7	12.7	5.4
	P deficient	64.5	74.1	8.4	11.5
$\text{Ce}^*$	Control	85.0	60.5	5.7	12.0
	P deficient	89.0	71.9	4.8	5.0

( $\text{Sr}^*$  injected intraperitoneally,  $\text{Pu}^*$ ,  $\text{Y}^*$ , and  $\text{Ce}^*$  injected intramuscularly.)

to a resorption of bone salt to replace the phosphorus lost in the excreta, in order to provide phosphorus for the essential needs of the soft tissues. In agreement with this view, it was found that the retention of  $\text{Sr}^*$  was greatly reduced in the phosphorus deficient animals (Table III). However, no significant effect on the retention of  $\text{Pu}^*$ ,  $\text{Y}^*$ , or  $\text{Ce}^*$  was observed.

Phosphorus-deficient animals were injected with radioactive elements, and were sacrificed four days later. The bones were removed, and radio-autographs were prepared. The latter was accomplished by exposing no-screen x-ray film to 10 micron sections of undecalcified bone sections until darkening of the film took place, the film darkening indicating the site of deposition of the radioactive materials. Owing to the extreme demineralization of

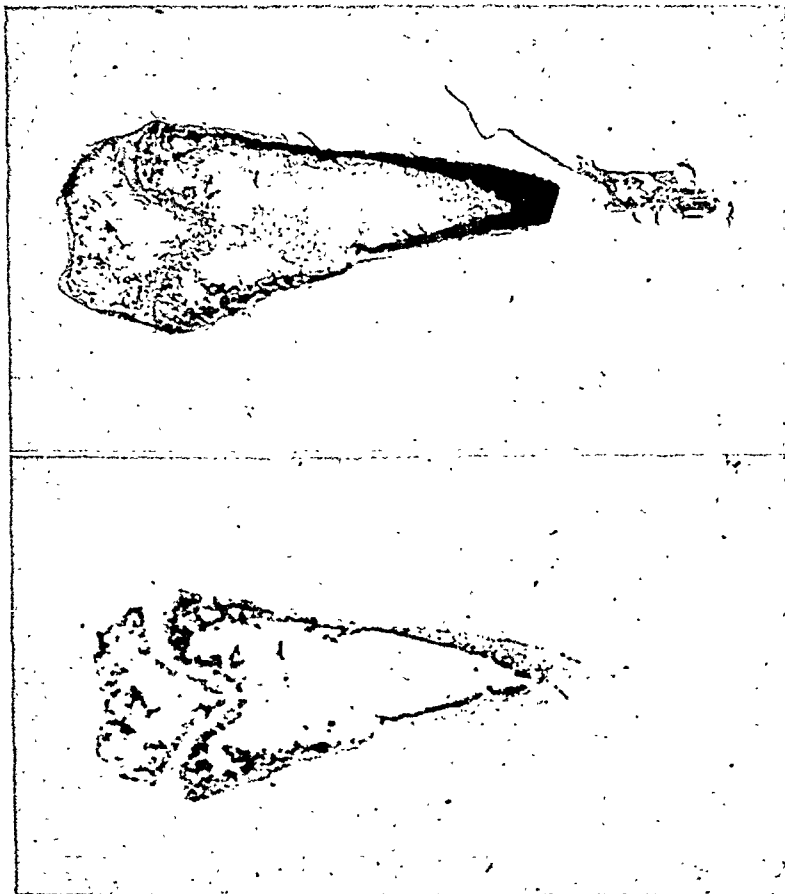


FIG. 2. Femur from rat weaned to phosphorus deficient diet at three weeks, injected intramuscularly with 20 micrograms plutonium at five weeks, and sacrificed at six weeks. Note heavy deposits of plutonium in the uncalcified osteoid matrix below the epiphysis, and superficial deposition of plutonium in the shaft. (Hematoxylin, eosin, and silver nitrate) ( $\times 7\frac{1}{2}$ ).

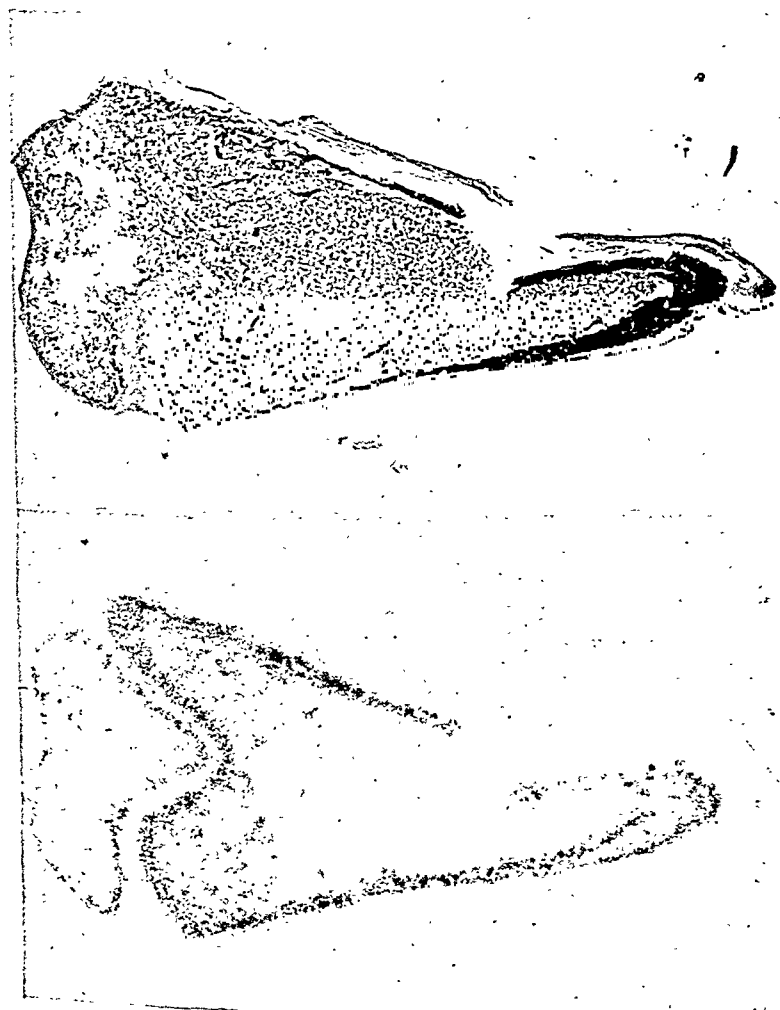


FIG. 3. Femur from rat weaned at three weeks to the phosphorus deficient diet, injected intramuscularly with 2.5 microcuries of yttrium at five weeks, and sacrificed one week later. Note superficial deposition of yttrium in the shaft, and heavy deposits in the uncalcified osteoid matrix below the epiphysis. (Hematoxylin, eosin, and silver nitrate) ( $\times 17$ ).

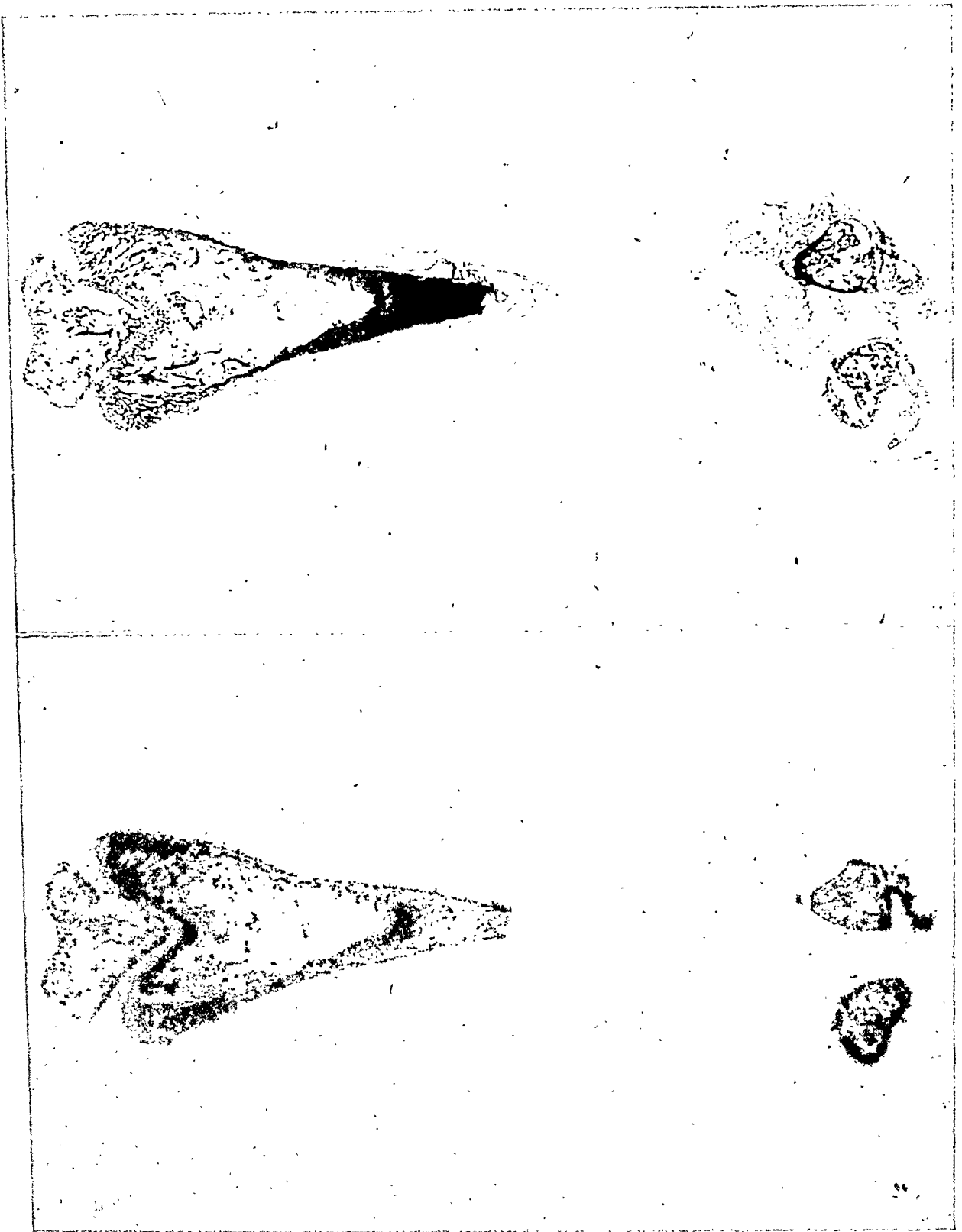


FIG. 4. Femur from rat weaned to phosphorus deficient diet, injected intramuscularly with 2.5 microcuries cerium at five weeks, and sacrificed one week later. Note the superficial deposition of cerium in the shaft, the heavy deposits in the uncalcified osteoid matrix below the epiphysis, and scattered points of radioactivity within the shaft. (Hematoxylin, eosin, and silver nitrate) ( $\times 8$ ).

the skeleton of these animals, large areas of the bone consisted of uncalcified organic matrix, free from bone salt. The radio-autograph for  $\text{Sr}^*$  (Fig. 1) shows that this element was deposited only in the thin shell of bone salt remaining in the shaft. Plutonium (Fig. 2), on the other hand, was actively laid down in the uncalcified organic bone matrix below the epiphyseal cartilage and in the endosteum and periosteum. None was deposited in the cartilage itself. Yttrium (Fig. 3) was deposited superficially in the shaft with heavy deposits in the uncalcified osteoid matrix below the epiphyseal cartilage. Similarly, cerium (Fig. 4) was deposited superficially in the shaft, with scattered points of radioactivity within the shaft, and heavy deposits in the uncalcified osteoid matrix below the epiphyseal cartilage.

Thus, a fundamental difference in the behavior of  $\text{Sr}^*$  as compared with  $\text{Pu}^*$ ,  $\text{Ce}^*$ , and  $\text{Y}^*$ , was indicated by the radio-autographic and metabolic studies.  $\text{Sr}^*$  appeared to follow the path of calcium metabolism and was deposited only in the bone salt;  $\text{Pu}^*$ ,  $\text{Y}^*$ , and  $\text{Ce}^*$  were laid down in the uncalcified organic matrix of bone and appeared to be unrelated to calcium in behavior. This is in sharp contrast to the generally accepted view with regard to the behavior of other heavy metals which deposit in the skeleton.

After the material has localized in the skeleton, the major problem is one of excretion. The curves in Figure 5 show the residue of the radioactive dose in the body plotted against time. By using semilogarithm paper, curves analogous to radioactive decay curves are obtained which give a measure of the biological half-life of each element in the body. They also indicate the relative stability of each element and show some of the features of elimination.  $\text{Sr}^*$  appeared to be eliminated more readily than the other elements, with a biological half-life of only three to four months.  $\text{Pu}^*$ ,  $\text{Y}^*$ , and  $\text{Ce}^*$  were excreted very slowly and the biological half-lives of these elements ranged from one to three years.

Treatments advocated in chronic radium poisoning<sup>3</sup> were investigated to determine their effect on the chronic elimination of these elements. The procedures, such as low calcium diet, parathormone, ammonium chloride and citrate, were all designed to cause some bone resorption and increased

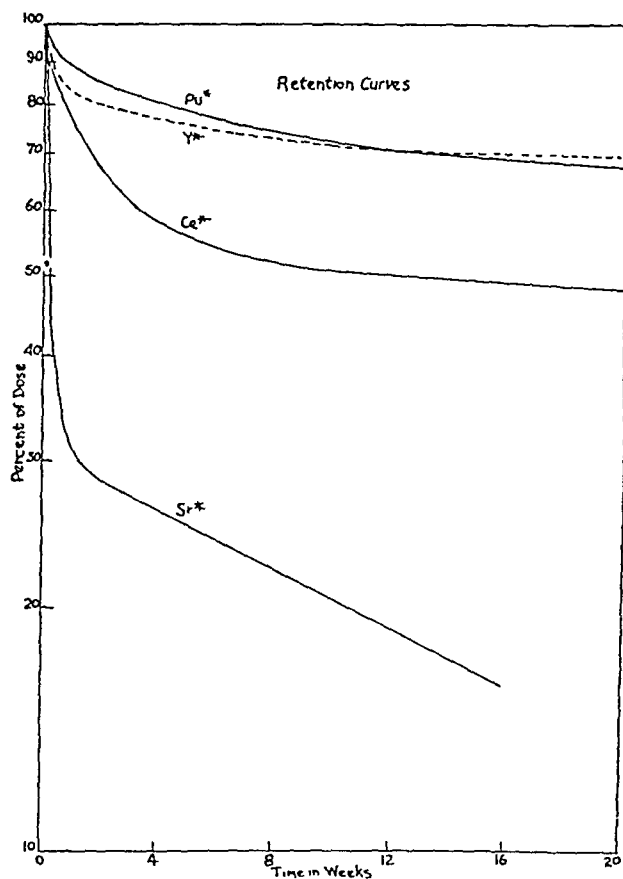


FIG. 5

excretion of calcium. They had no significant effect on the excretion of  $\text{Pu}^*$ ,  $\text{Y}^*$ , or  $\text{Ce}^*$ , and although they did cause a small increase in the excretion of  $\text{Sr}^*$ , it was still at too slow a rate to have any appreciable effect on the residue left in the body.

Since it did not appear feasible to remove the plutonium from the body by such means, some other method of reducing its toxicity in bone was sought. Radio-autographs showed that  $\text{Pu}^*$  was deposited on the surface of the bone and bone trabeculae, so that the radiations were concentrated on the cells of the endosteum, periosteum, and bone marrow, which might account for the high relative toxicity of plutonium. Since

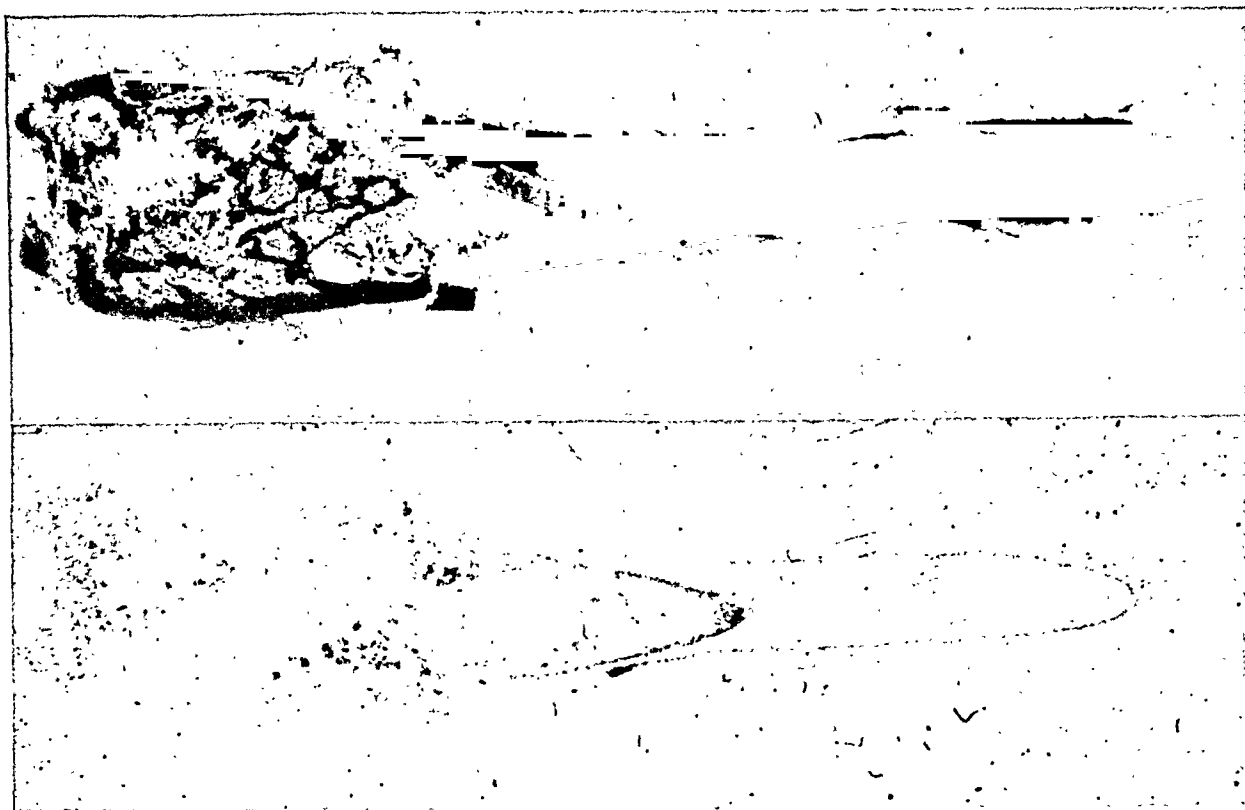


FIG. 6. Femur from an adult male rat which was injected intramuscularly with 25 micrograms of plutonium. Six weeks after injection the leg with the unabsorbed plutonium was amputated. After another six weeks, it was put on a diet deficient in calcium and phosphorus containing 2 per cent aluminum sulfate. After six weeks on this demineralizing diet it was changed to the stock diet supplemented with 2 per cent dicalcium phosphate and 2 per cent cod liver oil. It was sacrificed six weeks later. Note the linear plutonium deposit buried deep in the shaft, and the light plutonium activity in the bone laid down on top of it. Some of the trabeculae still contain plutonium, while others, possibly formed during regeneration, are free of plutonium. (Hematoxylin, eosin, and silver nitrate) ( $\times 6\frac{1}{2}$ ).

these deposits of  $\text{Pu}^*$  remain fixed, and since the range of the alpha particles is short, it was felt that by laying down new, non-radioactive bone on top of the  $\text{Pu}^*$  deposits, the short range radiations could be prevented from reaching the living cells. This was accomplished by placing rats which had been injected with plutonium for one month on a regimen designed to produce bone resorption, and then changing them to an optimum diet calculated to restore the bones with new non-radioactive bone. The results of this procedure are shown in the radio-autograph in Figure 6, in which the dense deposit of plutonium is buried deep in the shaft. This may provide a means for reducing the toxicity of plutonium in bone. It has not been as yet pos-

sible to test this method by actual toxicity studies in animals.

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For discussion see page 30.

# RETENTION OF RADIOACTIVE IODINE IN THYROID CARCINOMAS

## HISTOPATHOLOGIC AND RADIO-AUTOGRAPHIC STUDIES\*

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IN 1938 it was shown by Hertz, Roberts and Evans<sup>6</sup> that the mammalian thyroid was capable of selectively accumulating radioactive iodine following its intravenous injection as aqueous sodium iodide. In 1939 Hamilton and Soley<sup>2</sup> studied the uptake of radioactive iodine by the human thyroid. They reported<sup>5</sup> on a series of 40 patients, in 2 of whom there was thyroid carcinoma. In these 2 patients the cancerous thyroid tissue picked up only about 1 per cent as much of the radioactive material per gram as did the non-cancerous thyroid tissue. In later studies Hamilton and others<sup>3,4,5</sup> were able to trace the anatomical localization of radioactive iodine in human thyroid tissue and in cancers of that organ by utilizing the technique of radio-autography, a method originally devised by Lacassagne and Lattes<sup>7</sup> in 1924.

### PRESENT STUDY

During the past three years at Memorial Hospital tissue sections and radio-autographs from 19 cases of thyroid carcinoma have been prepared and studied. Included in this group are 4 cases which were generously made available by Dr. Seidlin of Montefiore Hospital and Dr. Keston of Bellevue Hospital. Several of the 19 cases had received large therapeutic doses of the eight day isotope ( $I^{131}$ ) but the large majority had received tracer doses ranging from 500 to 1,500 microcuries. The amount of inactive iodine was usually 0.05 to 0.1 mg. The objectives of this physical and histopathologic investigation were (1) to ascertain which of the various types of thyroid carcinoma possessed the ability to

retain the radioactive material; (2) to determine whether structural types were an important or minor influence in the ability of the tumors to pick up the isotope, and (3) to gain information as to whether this means of physiologic irradiation could be expected to achieve a palliative or curative influence in cases of thyroid carcinoma.

### PREPARATION OF RADIO-AUTOGRAPHS

The technique of radio-autography as employed in the cases reported here is a simple one and may be described briefly as follows. Tracer or therapeutic doses of radioactive iodine as sodium iodide in water solution are administered to the patient by mouth. Within twenty-four to forty-eight hours the anticipated surgical procedure is carried out. Blocks of tissue about 2-3 mm. in thickness are fixed in 10 per cent formalin. Wherever possible, blocks of non-cancerous thyroid are included and sufficient blocks are prepared from both the cancerous and non-cancerous tissue to insure that sections will be secured representing a complete picture of structural features present. The tissue blocks are dehydrated in dioxan and impregnated with paraffin. Thin sections are cut with a microtome and these are dried in an oven or over a flame. These procedures can be carried out with satisfactory results within the space of three to four hours. After the sections are dried the paraffin is removed by passing the sections through several changes of fresh xylene. The exposed surfaces of the de-paraffinized sections are then placed directly against the emulsion surface of a photographic plate or roentgen film. Brass

\* Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

weights maintain the sections in accurate position and they are exposed for varying periods of time depending upon the degree of radioactivity present. In this connection it has been found useful to make preliminary measurements of activity with a Geiger counter. Those sections which show little or no activity are exposed for as long as three weeks. At the end of the exposure interval the plates are developed and the sections are stained with hematoxylin and eosin. Areas of darkening on the photographic plate or film map out the distribution pattern of the radioactive material in the sections under scrutiny. This pattern can be effectively studied by comparing it with the stained tissue section by means of low power microscopy. It has been our practice to cut sections in quadruplicate and to make exposures from each of the four sections. This serves as a useful control and check over artefacts. This practice of multiple controls has well demonstrated the reliability of the method inasmuch as there is practically no variation in the patterns recorded on the various plates. Where variations do occur they can almost invariably be checked and explained by comparing the radio-autograph with the appropriate stained section.

In the process of preparing the sections for radio-autography the minute amount of the radioactive material lost in the solutions is of no significance. Frozen section technique alone or combined with paraffin technique was used in a few of the earlier cases. The freezing technique was found to be distinctly inferior to the paraffin method and was soon abandoned. The disadvantages of frozen sections include the undesirable qualities of thickness, the difficulty of securing entirely flat preparations and the unavoidable loss of colloid when the sections are manipulated in solutions. It cannot be expected that the paraffin technique entirely prevents the loss of some of the follicular colloid but it is distinctly diminished when compared with the results from frozen sections. The loss of colloid could probably be further

diminished by utilizing celloidin technique.

Study of the histologic distribution of the radioactive material can be greatly facilitated by the preparation of prints or transparencies enlarged from 10 to 20 diameters. Corresponding magnifications of the tissue sections are made for purposes of comparison. In our material it must be stated that the radio-autographs do not furnish an accurate cell by cell distribution of the retained isotope but one may successfully interpret the pattern as reflected by aggregate cell groups or large collections of colloid. The inability to orient structure and function in more minute detail is admittedly a handicap. For example, it is often not possible to be certain whether there is a greater accumulation of the isotope in acinar colloid or in adjacent epithelium. One may, however, ascertain this frequently enough for many determinations. When this can be done, it is necessary to have structural contrasts that are somewhat isolated so that they can be dissociated from the more diffuse and denser areas on the photographic plate. We have been unable to detect any deposition of the radioactive material in connective tissues and have found its deposit limited to epithelium and colloid. The failure to secure more accurate patterns is due to the fogging of structural margins caused by the diffusion and scattering of the longer range beta rays.<sup>1,3</sup>

#### CLASSIFICATION OF THYROID CARCINOMAS

Before presenting the histopathologic and radio-autographic findings in the 19 cases previously referred to, it seems necessary to illustrate and to comment briefly upon the various structural types of thyroid carcinoma and to point out the pleomorphism exhibited by this group of tumors when viewed collectively as well as individually. In Table I is a list of histopathologic types of thyroid carcinomas, for which no originality is claimed. In the right hand column is an expression of the relative frequency of each type.

*Papillary Adenocarcinoma.* Fortunately

this is the most frequent form of thyroid carcinoma and the group yielding the most satisfactory clinical results. Characteristically the tumors are of a low order of malignancy. Figure 1 shows a coarsely papillary thyroid carcinoma containing characteristic dark round calcific concre-

*Follicular and Alveolar Adenocarcinoma.* The term follicular as used here implies the reproduction in a thyroid tumor of structures having some resemblance to thyroid follicles. Hence it is used in a descriptive and not a derivative sense since the thyroid follicles for practical purposes are the

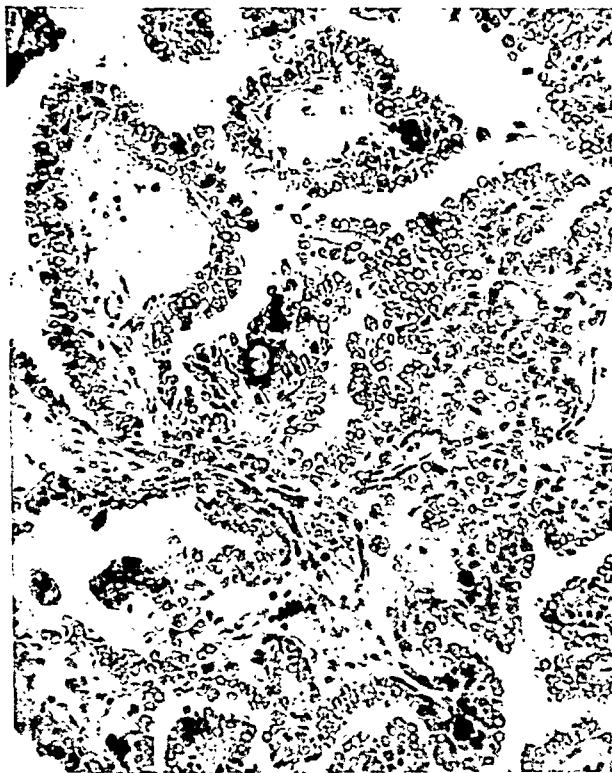


FIG. 1



FIG. 2

tions usually referred to as psammoma bodies. In Figure 2 is another structural type of papillary thyroid carcinoma made up of rather orderly cuboidal and columnar cells arranged usually in a single row along delicately vascularized connective tissue cords containing very little stroma. In both Figures 1 and 2 the lack of true gland formation and the absence of colloid should be noted. These papillary tumors have a tendency to occur in young individuals, but they are well known in the later decades of life. It is the only form of thyroid carcinoma familiar to us as showing rather uniformly at least a moderate degree of sensitivity to roentgen rays. Fatal cases of this disease are quite apt to run a very prolonged clinical course often covering a number of years.

ultimate source of all thyroid carcinomas. The term alveolar as herein employed refers to a structural arrangement less differentiated than the previously used term, follicular, and moreover one can refer to open alveolar where there is lumen forma-

TABLE I  
CLASSIFICATION OF THYROID CARCINOMA

	Per Cent
Papillary adenocarcinoma	40
Follicular and alveolar adenocarcinoma	20
Solid alveolar adenocarcinoma	25
Anaplastic carcinoma	2
Hurthle cell adenocarcinoma	5
Spindle and giant cell carcinoma	5
Metastasizing struma	3



tion or solid alveolar where cellular proliferation has left no residual lumen. In Figure 3 is an illustration of a follicular and alveolar adenocarcinoma. Here and there are follicle-like structures which contain pink-staining material having the appearance of colloid. There is considerable variation in the contour and cellularity of the

grade malignancy and the rate of cure is very low.

*Solid Anaplastic Thyroid Carcinoma.* This constitutes a small group of thyroid carcinomas in which near total or total lack of differentiation is seen. In Figure 5 is such a tumor with a structural pattern so indifferent that it simulates the histopatho-



FIG. 3

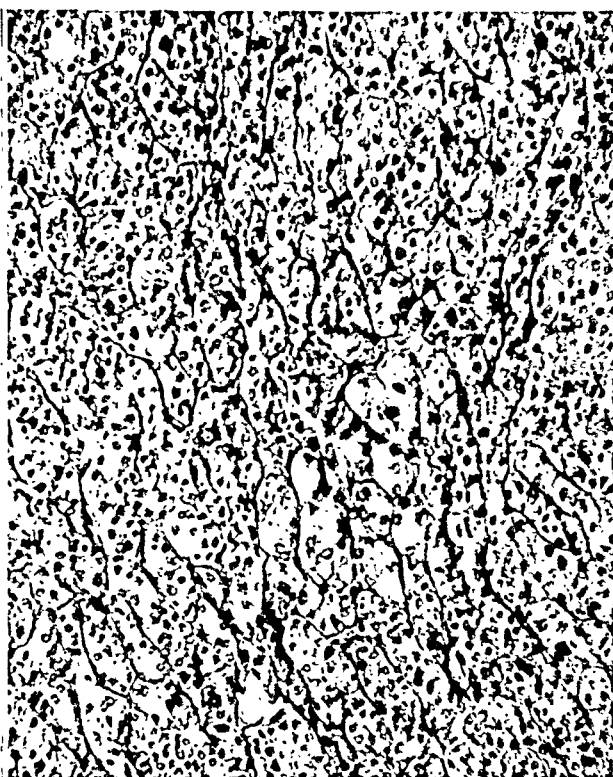


FIG. 4

follicular groups and in some areas alveolar formations with and without lumina are present. Thyroid tumors exhibiting the structural qualities seen in Figure 3 are distinctly more clinically malignant than the papillary group previously discussed.

*Solid Alveolar Adenocarcinoma.* This group could easily be merged with the preceding group but is discussed separately here inasmuch as a certain significant number of thyroid adenocarcinomas are almost exclusively solid alveolar in structure. In Figure 4 is shown a very cellular solid alveolar tumor with much nuclear variation as to size and depth of staining. Note that no colloid is present since there are no lumina. This is a tumor of quite high

logic traits of lymphosarcoma. Indeed, on some occasions the anaplasia is so marked that one finds it difficult to separate this tumor from lymphosarcoma. Unless some alveolar grouping of cells or other epithelial qualities are demonstrable in these cases definite diagnosis cannot be made. As might be expected cure in such cases is a great rarity.

*Hurthle Cell Adenocarcinoma.* This is one of the most characteristic histopathologic forms of thyroid carcinoma and is featured by the presence of bright pink-staining cells. This tinctorial quality is confined to the cytoplasm which is usually abundant and rather opaque. Most commonly the cell type concerned is columnar and the cells

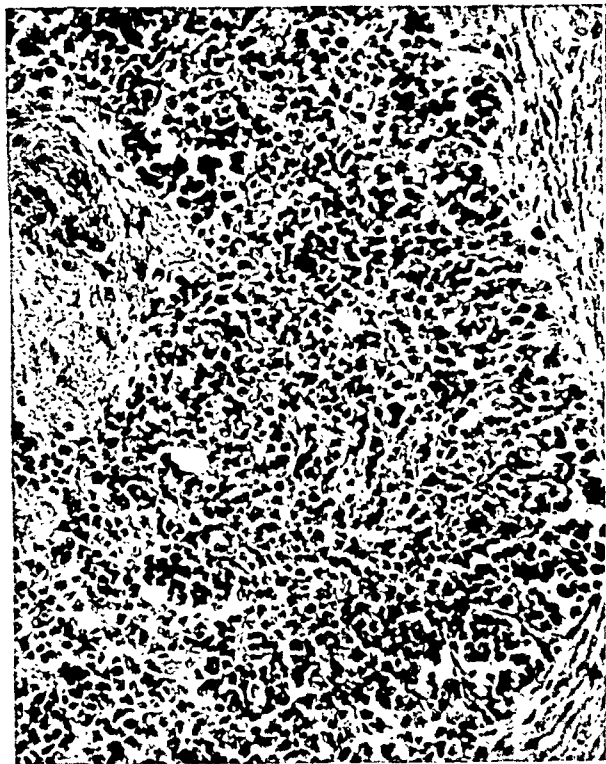


FIG. 5



FIG. 6

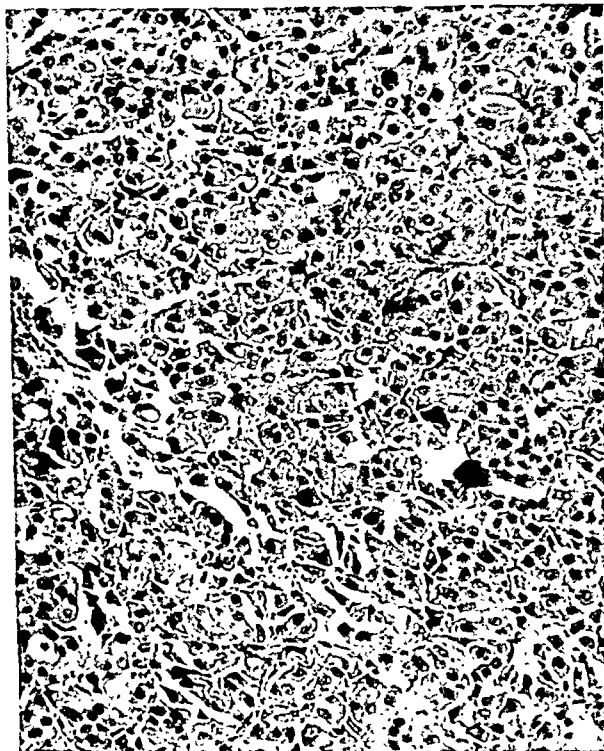


FIG. 7

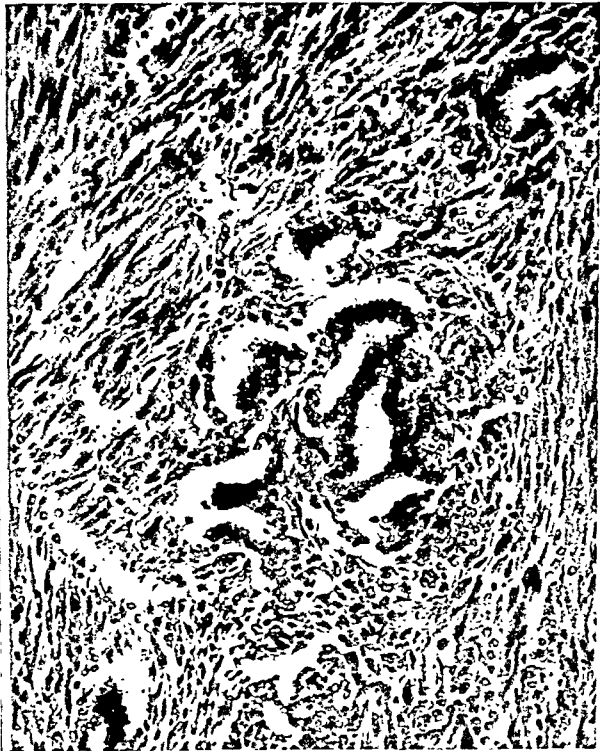


FIG. 8

tend to be stratified in plexiform groups separated commonly by a rich thin-walled capillary blood supply. Such a tumor is

shown in Figure 6. In Figure 7 is a less common form of Hurthle cell adenocarcinoma, more diffuse and made up of more rounded

and polygonal cells somewhat similar in shape to hepatic cells. Generally speaking, Hurthle cell carcinomas tend to metastasize late and to run a prolonged clinical course, exceptional cases surviving for many years. The less differentiated Hurthle cell carcinomas, few in number, are capable of early metastatic dissemination.

*Spindle and Giant Cell Carcinoma.* A dual descriptive designation is given to this group since a certain small number of highly malignant thyroid carcinomas are characterized by the presence of both spindle and giant cells. There are members of this group which are predominantly spindle cell and others that are chiefly giant cell. If one preferred, separate listings could be made for these tumors in which there is a predominating structural component. Figure 8 represents an area from a thyroid carcinoma principally spindle cell in make-up. Here and there, however, are a few residual areas of atypical gland formation. In Figure 9 is a highly anaplastic thyroid carcinoma made up of quite large indifferently arranged giant epithelial cells.

In thyroid cancers studied by us, spindle and giant cell carcinoma is the most malignant single neoplasm of this organ. We do not have in our records a single cure of this form of the disease.

*Benign Metastasizing Struma.* This term refers to a rare form of thyroid tumor characterized by the ability to yield metastatic growths in distant foci while maintaining a peculiarly benign histopathologic appearance. The term, benign, used in reference to this peculiar tumor is a structural and not a clinical designation. It is admittedly defective inasmuch as all component parts of a tumor classified as benign metastasizing struma may not be strictly benign in aspect. The more material one studies from cases classified in this group, the more impressed he is with the presence in both primary and metastatic lesions of areas having the morphologic aspect of fully malignant thyroid carcinoma. Multiple sectioning is often necessary to develop these qualities but when looked for they become more the rule than the exception. In Figure 10 is pictured an example of

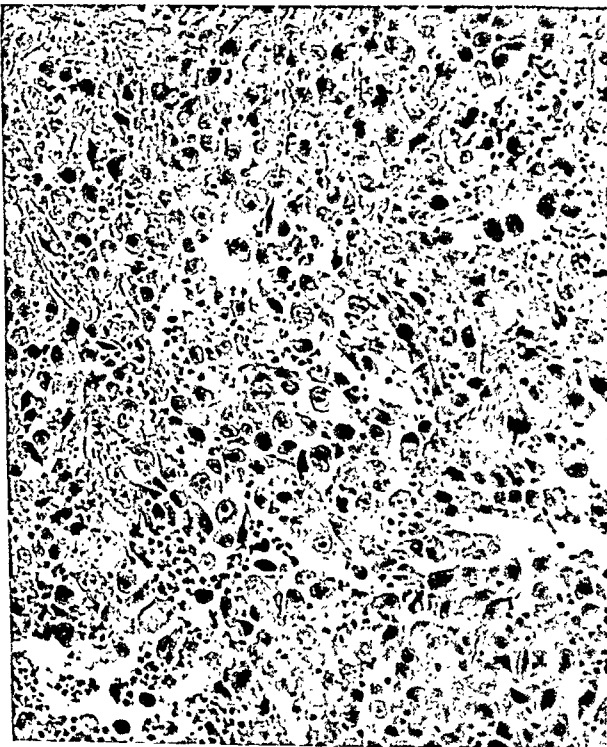


FIG. 9

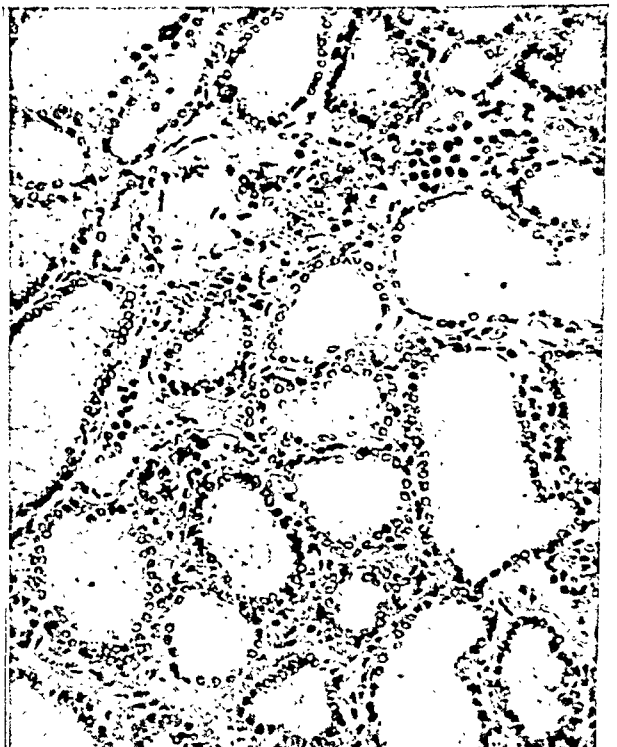


FIG. 10



FIG. 11

so-called benign metastasizing struma. The photomicrograph was made from a lung metastasis. Observe the uniform follicular structure and the abundantly distributed colloid.

Figures 1 through 10 should serve to illustrate the broad range of histopathologic structure that is encountered in thyroid carcinomas as a group. Actually the range of structural variation in these tumors is much greater than can be shown in a limited number of photomicrographs. It must be understood that the foregoing classification scheme is by necessity more explicit than is actually the case. Thyroid cancers are seldom pure and homogeneous in their microscopic make-up. Often there is interplay between papillary and follicular structure or an intermixing of follicular and solid alveolar areas. Hence in making any classification scheme it is necessary to classify on the basis of dominant structural traits or to use a complicated terminology sufficient to designate multiple structural traits. For these reasons any classification of thyroid carcinomas must be partially



FIG. 12

defective. In making routine diagnoses of thyroid carcinomas our practice has been to report the various structural features present and to give some numerical estimate on a basis of one to four as to the degree of malignancy. In certain extreme cases of thyroid cancer a single tumor may contain almost every structural type listed in the preceding classification scheme. Perhaps the purest histopathologic type is the Hurthle cell carcinoma. In regard to so-called benign metastasizing struma, homogeneity of structure becomes less outstanding when one is able to examine multiple blocks from a given tumor site or blocks representing multiple metastatic foci. The structural variations discussed have an important bearing on the ability of thyroid tumors to pick up radioactive iodine, as will be seen in the following.

#### CORRELATION OF RADIO-AUTOGRAPHIC AND HISTOPATHOLOGIC FINDINGS

It is scarcely surprising to find that a group of neoplasms of such diverse histo-

pathologic make-up differ in their ability to retain radioactive iodine. The illustrations that follow will serve to establish this point of view. The illustrations are shown in pairs and the left panel will represent the tissue section, the right panel the corresponding radio-autograph. Each tissue radio-autographic pair is reproduced at identical magnification.

In Figure 11 is a section of a low grade

amount of isotope as judged by the degree of darkening caused by other thyroid tissue present. Detail is insufficiently shown to enable one to state whether the colloid or the epithelium in this adenomatoid nodule is the site of principal storage.

A section of another primary tumor is shown in Figure 13. The tumor is composed of both papillary and follicular elements. The upper two-thirds of the left border of



FIG. 13

papillary adenocarcinoma. The tumor is clearly demarcated from adjacent non-cancerous thyroid tissue. This section of tumor is unusually homogeneous, being papillary throughout. In Figure 12 is the corresponding radio-autograph which demonstrates that the areas of darkening outline the non-cancerous thyroid tissue. There is absolutely no darkening of the plate where it was in contact with the tumor itself. At the lower left of Figure 11 is an oval area which histologically represents an inactive-looking adenomatoid nodule rich in colloid. In Figure 12 this oval area is shown to have picked up a relatively large



FIG. 14

the tissue section is made up of purely papillary tumor. The radio-autograph in Figure 14 reveals no darkening that corresponds with this area of purely papillary tumor. In the lower half of Figure 13 are four rounded nodules and there is a fifth similar nodule at the upper right of the section. These nodular areas represent low grade thyroid adenocarcinoma combining both papillary and follicular qualities. If one compares the degree of darkening that these areas have produced on the radio-autograph it becomes apparent that the retention of the isotope is not entirely uniform. From nodule to nodule the rela-

tive amount of papillary tissue as opposed to follicular tissue is more nearly equal than is the degree of darkening that these nodules have produced in Figure 14. This statement is based on similar patterns in quadruplicate sections and radio-autographs.

Figure 15 represents three adjacent lymph node metastases of papillary and fol-

licular in the last two cases. They are presented as exceptions rather than the rule.

An orderly follicular thyroid adenocarcinoma is seen in Figure 17. The corresponding radio-autograph of Figure 18 gives evidence of uniform retention of the administered isotope.

Another orderly follicular carcinoma with a rim of adjacent thyroid tissue is il-



FIG. 15

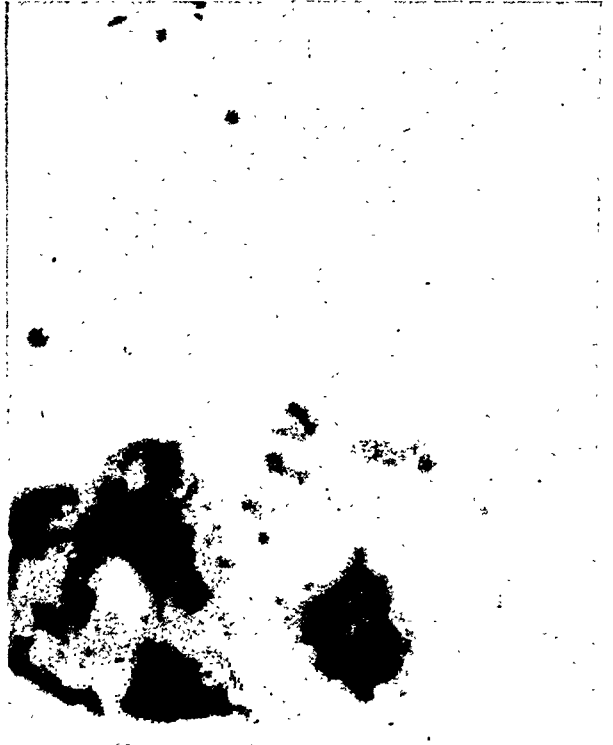


FIG. 16

licular thyroid adenocarcinoma. Somewhat the same situation is present in Figures 15 and 16 as seen in Figures 13 and 14, namely that here are examples of essentially similarly constituted tumors having a distinctly different ability to retain the radioactive isotope. The larger node section in Figure 15 exhibits a fairly satisfactory pick-up pattern but the tumor tissue in the upper smaller nodes is almost totally non-functional. That this is not due to artefact is revealed by repetition of these findings in quadruplicate sections and radio-autographs. Under ordinary circumstances there is much closer correlation between structure and pick-up pattern than shown

illustrated in Figure 19. Study of the corresponding radio-autograph in Figure 20 reveals a relatively low pick-up in the tumor as contrasted with the pick-up pattern of the noncancerous thyroid tissue seen in the lower left hand corner.

In the cases so far studied we have found no example of thyroid carcinoma of high-grade malignancy that demonstrated the retention of radioactive iodine with one exception. This is shown in Figure 21 which is a medium magnification of a solid alveolar adenocarcinoma; in Figure 22 is the corresponding radio-autograph. The section was taken from a lymph node metastasis. The possibility of artefact was





FIG. 17



FIG. 18



FIG. 19



FIG. 20



FIG. 21



FIG. 22



FIG. 23



FIG. 24



eliminated by securing equivalent results in four mounts. Functional capacity on the part of this structural type is presently considered quite exceptional.

A Hurtle cell adenocarcinoma is pictured in Figure 23. The tumor occupies the central portion of the section and is surrounded almost entirely by a rim of ad-

#### SUMMARY OF RADIO-AUTOGRAPHIC AND HISTOPATHOLOGIC FINDINGS

From the foregoing it is clear that certain types of thyroid carcinoma do possess the ability to accumulate radioactive iodine. Furthermore it appears that structural type is an important determining factor. Gen-

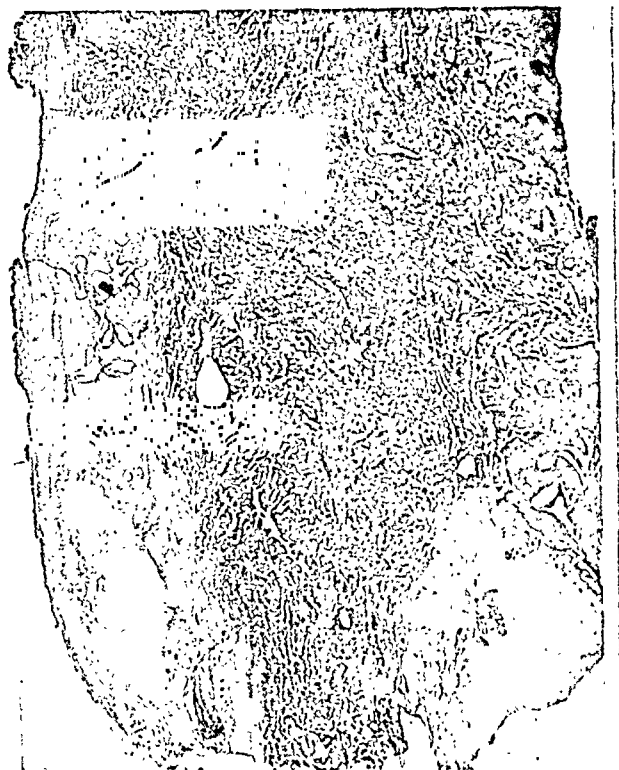


FIG. 25

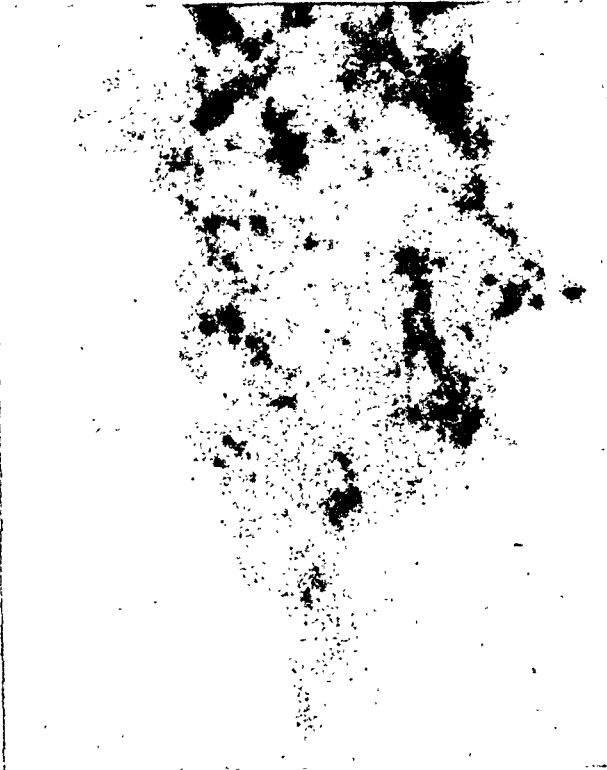


FIG. 26

jacent thyroid tissue. The tumor itself is partly hemorrhagic and broken down. The corresponding radio-autograph (Fig. 24) fails to show the deposit of any isotope in the tumor itself.

The uniformly good pick-up pattern of so-called benign metastasizing struma can be seen in Figures 25 and 26. In the tissue section (Fig. 25) one sees the distribution of the tumor within a portion of rib. The radio-autograph (Fig. 26) gives a very complete outline of the central tumor and its peripheral extensions into the cortical bone.

erally speaking, pick-up of the radioactive material is closely linked with structural qualities which include orderly cell arrangement in follicular pattern and the presence of colloid-like material. It is evident that these morphologic factors hold true for metastatic as well as for primary tumors.

In the 19 cases included in this study there were 10 in which the presence of radioactive material was detectable by means of radio-autographic determinations. Five of these were examples of benign metastasizing struma. The remaining 5 had the structure of follicular adenocarcinoma

in some portion of the material studied. It has already been pointed out that there is frequent interplay between papillary and follicular features in certain thyroid carcinomas. Due to technical difficulties it is not always possible to orient the pick-up pattern in sufficient detail to be certain that any of the papillary portions of the tumor were functional. In 2 cases the evidence of pick-up in limited papillary areas was suggestive but not absolute. In only 1 case in this series of 19 was there evidence of function in a tumor that was regarded as highly malignant and free from colloid or follicular pattern. In the 9 cases yielding negative results there were 3 Hurthle cell carcinomas and the remainder were either solid alveolar or more anaplastic thyroid carcinomas. It is necessary to state that in some of those cases which yielded positive radio-autographs there were portions of tumor that gave no evidence of ability to pick up the isotope. The only type of thyroid carcinoma not yet studied is spindle and giant cell carcinoma. It would appear optimistic to believe that this type would be functional.

The reporting of positive findings in 10 of 19 cases of thyroid carcinoma is misleading unless qualified and it is stressed that many of these 19 cases were selected. Tracer doses have been administered to a number of cases in which functionability was demonstrated to be absent by other means such as determining that excised or in situ tissues did not contain radioactive material. On the basis of present findings and the estimation of the relative frequency of the various types of thyroid carcinomas approximately 15 per cent of thyroid cancers may be expected to accumulate radioactive iodine in some degree. The most favorable histopathologic type of thyroid cancer is the so-called benign metastasizing struma. Thus far, no case of this type has yielded a negative result. Nearly the same statement can be made in regard to orderly follicular thyroid carcinoma but the avidity of the cells of this

tumor does not approach that seen in metastasizing struma. Attention is again directed to the lack of uniformity in the pick-up pattern of various thyroid carcinomas that prove to be functional in some measure. This is largely explained upon the structural grounds previously discussed but it is to be remembered that very poor pick-up and sometimes no pick-up at all is seen in some portions of thyroid tumors whose structure would ordinarily indicate the ability to retain the isotope.

From the above discussion it is apparent that despite the rather close relationship between histopathological pattern and radioiodine pick-up, a clean-cut decision on the advisability of palliative or curative radioiodine therapy cannot be made on the basis of a limited biopsy since such a specimen may not reveal the more favorable histopathologic patterns that may be present. For example, in a recent case not included in this series the initial pathologic material revealed an unfavorable papillary tumor. In spite of this a tracer dose was administered and, by external measurements with the Geiger-Müller counter, evidence of appreciable uptake was found in a bulky rib metastasis. Biopsy from this area yielded tumor tissue in which the histopathologic structure was quite different from that previously seen, being orderly follicular carcinoma, a relatively favorable form for radioiodine therapy. A very conservative attitude on this subject would point to the treatment of metastasizing struma only.

The hopelessness of metastatic thyroid cancer and the radioresistance of the more functional forms, however, counsel a more extended therapeutic trial in all cases in which external measurements reveal the presence of the isotope in metastasis irrespective of the possible heterogeneous deposition of iodine that may be present therein. In this connection it must be borne in mind that radio-autographs do not indicate the exact distribution of radiation in a tumor because they are obtained from

radiation originating in a few microns of tissue and not in a tissue block of thickness comparable to the range of the beta particles.

Mention also must be made of the fact that since the isotopes of radioiodine emit gamma rays, there remains the possibility of administering the isotopes in amounts sufficient to deliver gamma radiation throughout heterogeneous tumors by using the functional foci of the latter as so many sources of interstitial radiation instead of relying exclusively on the corpuscular radiation.

The selective deposition of iodine in the organism and the lack of untoward effects in the case treated by Seidlin, Marinelli and Oshry<sup>8</sup> provide some justification for such an attempt, but lack of experimental data on the radioiodine tolerance of the human organism precludes closer estimate of the probability of success by such a procedure. Therapeutic attempts now in progress will provide the answer to this interesting question.

Sight must not be lost, either, of the possibility that therapeutic means may be developed to increase the deposition of radioiodine in thyroid tumors. If, for example, thyrotropic hormone could be shown to increase functional activity in these tumors a potentially useful booster mechanism would become available. Temporary kidney block should also be contemplated inasmuch as it is known that this organ, through its excretory function, competes with functional thyroid tissue for whatever inorganic iodine is present in the blood stream and may prove ultimately to be the organ which sets the upper limit of tolerance to radioiodine administration.

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DISCUSSION OF PAPERS BY DRS. JONES;  
LOW-BEER; COPP, AXELROD AND  
HAMILTON; AND MARINELLI,  
FOOTE, HILL AND HOCKER

DR. ROBERT S. STONE, Berkeley, Calif. It is now well over ten years since artificial radioactive materials first began to be used, and we find ourselves still asking "What is going to happen to them in the future as therapeutic agents, or what other useful purpose will they serve"? The truth of the matter is that they have served tremendously useful purposes in non-spectacular ways, but that the things which the lay press tries to make spectacular from time to time, and which we would like to be spectacular in our medical work, just haven't materialized as yet. We keep trying to find new ways in which radioactive materials will be useful.

I think we should recognize that there is not likely to be any spectacular way in which they are going to be useful and that we might as well take the step-by-step progress which has been going on and which will continue to go on as the main method of advancing. We can continue to hope that something of a more spectacular nature or a more rapid advance may develop. You all recall that the early work of Dr. John Lawrence in the treatment of leu-

kemia with radioactive phosphorus gave promise of greater things to come. Instead, just recently Dr. Lawrence himself published a paper in your journal which showed that it probably never will be possible to kill leukemic tissue without killing the bone marrow itself. Nevertheless, the treatment of leukemia with radioactive phosphorus has become a standard and very satisfactory means of treatment.

Dr. Jones mentioned many of the steps forward that have come and yet the only selective thing that has definitely been found in his work is the location of the chromium phosphate in different tissues. We look forward to a time when the biochemists and physiologists will be able to localize various radioactive compounds in selected tissues and then we may be able to apply them successfully to therapy.

Dr. Copp's paper dealing with how certain elements are metabolized in the body is one of the steps in that direction. His results do not yet suggest any way of applying his methods to therapy. It was developed, of course, to help out on the plutonium project (Manhattan Project) with regard to where plutonium was locating in the body, but it is one of those studies, of which there were a great many done during the war on the plutonium project, to let us know where the various radio elements are going to locate. It isn't an easy thing to figure out how we are going to help patients with these elements, but I think a considerable advance has been made.

Dr. Low-Beer's work has been very interesting to watch. It has been very useful work, and I think it has accomplished some things that cannot be accomplished with other methods of therapy, but after a number of years have gone by, if you have given large doses of beta rays from phosphorus, you begin to find thin papery skin and telangiectasia the same as you find after any large dose of radiation, whether it is contact therapy, or million volt therapy, and the only way to avoid affecting the skin is to treat deep tissues with some of the other materials that Dr. Jones mentioned as in the offing, or with the protons and the beta rays of high energy, which may be sent through the skin without influencing it. Then we will have the problem on our hands of getting "telangiectasia" in the deep tissues instead of in the skin, and we won't be able to detect it until it is too late.

The work from Memorial Hospital is one of the most interesting subjects. The treatment of

carcinoma of the thyroid with radioactive iodine is the only example of the localization of an element being used as means of therapy. They do not bring out in the paper that the radioactive iodine for the treatment of the thyroid cost them somewhere around four thousand dollars, so it doesn't become a very economic method of treatment unless we can get some other source of iodine that will be less costly.

That brings me to one more point that I want to make in closing and that is that in order to emphasize the peaceful uses of atomic power in medicine, the Manhattan Project has taken advantage of the fact that radioactive elements are examples of atomic power. Now, of course, there are practically no radioactive elements that are the result of chain reacting piles that could not be made on the cyclotron before the war. It is just a question of quantity, and now they are coming face to face with the problem of how to distribute these elements to the country as a whole and what to charge for them.

I happen to have attended a few of the conferences recently when they were trying to work out the cost of these materials. I think that those of us who have used radioactive materials in the past will appreciate more what Professor Ernest Lawrence and his staff operating the cyclotron at Berkeley have done for us in giving us radioactive materials when we find out how much it will cost merely to pay the Army their out-of-pocket costs. These radio elements are going to be rather costly tools with which to work.

I would like to refer all of you to the recent issue of *Science*\* which describes how the Manhattan Project is going to distribute radio elements throughout the United States and tells considerable about what ones are available and how to obtain them. It is going to be difficult to produce and separate them. The piles, where the chain reaction goes on in controlled conditions were not built to make radioactive materials. They were built to make plutonium. It is going to require considerable expense and time to adapt the present piles and laboratories to the production of radioisotopes. This has been an interesting symposium, and the Society has profited much by the presentations.

DR. JOHN H. LAWRENCE, Berkeley, Calif. Dr. Stone has given such an excellent discussion of

\* June 14, 1946, 103, 697-705.

these papers that there really isn't much to add, and I'll speak very briefly. I think that Dr. Jones has given a very excellent discussion of the possible applications of some of these newer developments in nuclear physics to radiation therapy, and I think he has impressed upon you the numerous applications of the tracer technique in metabolic studies. He has some very exciting things he could talk about along these lines.

With reference to Dr. Marinelli and his associates' work, and also the work of Dr. Copp using the autoradiographic technique, all of us would hope that one could actually get cell definition from radio-autographic work, and some of us have tried to place our sections in a strong magnetic field so we could pull the beta rays straight out and get real cell definition. Then this technique would be very useful in this type of investigation. This work of Marinelli and Copp shows that you can't get cell definition although one can differentiate colloid from the cellular radio-iodine to some extent. The physicists tell us we are wasting our time to try to pull these beta rays straight out with any magnetic field available, so the technique cannot be improved upon by this method.

I want to add one remark regarding leukemia.

In 1938 we presented exploratory work in the treatment of leukemia by radioactive phosphorus and made a progress report before this Society. We have analyzed the records of cases that have been treated since 1936. We have approximately ten years' experience, and as you all know, there is great difficulty in evaluating therapy in such a disease; you have to wait a lifetime before you get end-results in such a chronic disease.

To give you an indication of what the findings are showing in the case of the first hundred unselected cases of chronic myelogenous leukemia, the average length of life, as of last week—and about 15 of these cases are still alive—and counting their length of life as of today, is about three and one-half years.

Now, in the chronic lymphatic series, analysis of a similar group of 55 cases treated since 1936 shows the average length of life to be about four and one-half years. As Dr. Stone pointed out, in this form of therapy you do not have the degree of selective irradiation you want.

In *Science* (1946, 103, 697) there is a discussion of radioisotopes available from the pile. Between the cyclotron and the pile, these isotopes are now becoming widely available.



## NEPHROCALCINOSIS\*

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and THOMAS D. KINNEY, M.D.

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THE term "nephrocalcinosis" has been used to describe several conditions which have widely different etiologies. In general, they have the common finding of calcium deposits in the renal parenchyma which may be found in the pyramids alone, or in the cortex, or in both. It is the purpose of this paper, to review the subject of nephrocalcinosis and to discuss the pathological and physiological processes involved. In addition, a case of chronic nephritis with extensive calcification of the kidneys, ending in typical renal insufficiency and death, is presented.

## PHYSIOLOGICAL CONSIDERATIONS

The calcium, phosphorus and protein of the blood exist in intimate relationship with each other. Normally some 60 per cent of the serum calcium is in combination with protein and in this form it is non-diffusible through a colloidin membrane. The inorganic blood phosphate concentration bears an inverse relationship with the concentration of the ionized calcium, so that these ions are in equilibrium with the calcium phosphate of the blood, according to the well established chemical formula  $(Ca^{++} \times (P\equiv)^2 = k$ , where  $k$  is a constant known as the solubility product constant. It should be noted that  $k$  is constant only for a fixed pH, having a lower value at a higher pH and a higher value at a lower pH, so that the concentration of calcium and phosphorus soluble at pH 7.4 may not be completely soluble at pH 7.5. At the normal blood pH, the relationship  $(Ca) \times (P) = 36$ , where the concentrations are expressed in milligrams per cent, holds fairly well. However, this equation is dependent upon all of the blood inorganic phosphate remaining in a diffusible form, which is probably not always the case. Grollman<sup>17</sup>

has shown that in mammals all of the inorganic blood phosphate is diffusible in the normal state, but as the calcium level is raised to levels of 12 mg. per cent or more, significant percentages of the phosphate become non-diffusible. This author postulated the formation of a colloidal complex of calcium phosphate in loose combination with protein, which would render the phosphate incapable of passage through a colloidin membrane. It seems probable that such a mechanism as this was the factor which has led to some authors<sup>13</sup> placing the level at which metastatic calcification occurs at  $(Ca) \times (P) = 100$ , since such a state of supersaturation could be easily produced by the formation of the colloidal complex.

Many factors enter into control of the excretion of calcium and phosphorus. Normally over 60 per cent of ingested calcium is excreted by way of the bowel, while the greater part of phosphorus is lost in the urine. The renal threshold for calcium reabsorption is at a blood level of 7 mg. per cent,<sup>1</sup> so that this ion is continuously being lost in the urine, and the rate of loss is roughly proportional to the height above 7 mg. per cent at which the blood calcium lies. Renal excretion of phosphorus has been shown to be intimately related to the activity of the parathyroid gland. Parathyroid hyperactivity is associated with an intensified phosphaturia, while hypoactivity results in decreased phosphate excretion. The calcium excretion is secondarily affected in both instances. When the excretion of phosphates is rapid, the blood phosphates fall to subnormal levels, giving rise to higher calcium levels and consequent increased calcinuria. Contrariwise, when the phosphate excretion is subnormal, the blood level is increased and the blood

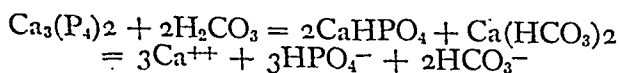
\* From the Departments of Medicine, Radiology and Pathology of the Peter Bent Brigham Hospital and Harvard Medical School, Boston, Massachusetts.

calcium level falls with consequent decrease in its urinary excretion. Thus, when the excretion of phosphorus is rapid or slow as the result of parathyroid activity, the excretion of calcium is respectively also rapid or slow. In uremia, however, despite the slow excretion of phosphorus by the decreased glomerular mass, the calcium loss from the body may still be rapid as a result of the acidosis that accompanies this condition. This is due to the inability of the tubules to elaborate enough ammonia to cover the acid products of metabolism and therefore a fixed base is called upon instead. Calcium is especially suitable because it has a double valency, allowing one ion to cover more acid, and because it has a large reservoir in the bone.

#### PATHOLOGICAL CALCIFICATION

Pathological calcification in human tissue may result from one of two mechanisms: (1) abnormally high concentrations of calcium or phosphate in the blood with precipitation of calcium phosphate in healthy tissues, or (2) local tissue damage with precipitation of calcium in the presence of normal blood levels. It is significant that the areas of predilection for abnormal calcification are areas where there are marked changes in the pH of the media, or where there is an increased concentration of phosphatase. It seems most probable that this precipitation occurs from a colloidal suspension of the calcium phosphate-protein complex in instances of hypercalcemia or from non-colloidal ionic solutions when the blood levels are normal. It is not surprising that precipitation should occur more readily in the former instance, where there is already a state of supersaturation.

In the lungs one element which tends to hold calcium phosphate in solution is lost from the blood due to rapid loss of  $\text{CO}_2$  in the change from venous to arterial blood. This is seen in the equation:



According to the mass-action law, the

pulmonary process of removing  $\text{CO}_2$  from the system would, by reducing the amount of  $\text{H}_2\text{CO}_3$  present, drive the above reaction to the left and calcium phosphate would be precipitated. The gastric mucosa is a favorite site for calcification. The process of secreting acid contents into the stomach leaves the secretory cells alkaline, creating a medium in which calcium phosphate is quite insoluble. A similar process takes place in the renal tubules where acidification of the urine necessarily renders these cells alkaline. In addition, these cells are high in phosphatase. Similarly the media of the aorta and larger arteries, a favorite site for calcium deposits, are high in phosphatase.

*Calcification Due to Abnormally High Concentration of Calcium or Phosphorus in the Blood.* The first type of calcification occurs occasionally in hyperparathyroidism, with multiple deposits in the kidneys as well as throughout the body, particularly in the periarticular areas, the lungs, the gastric mucosa, and the large blood vessels. Similar incidences of this type of reaction have occurred following intoxication with vitamin D where blood calcium levels have reached very high levels.

In 1934, in a review of 83 cases of hyperparathyroidism, Albright, Baird, Cope and Bloomberg<sup>2</sup> noted that some 50 per cent of their cases had associated renal complications. Somewhat over half of these had precipitation of calcium in the renal pelves with concurrent pyelonephritis. The rest were characterized by precipitation in the tubules with resultant sclerosis, contraction, and insufficiency in renal function. They felt that the renal lesion of hyperparathyroidism was an index of the severity of the disease, while the amount of osteitis fibrosa cystica was an index of the duration of the disease. That abnormal precipitation of calcium in the kidneys can actually occur from overdosage with the parathyroid hormone was shown experimentally in the rat by Chown, Lee, Teal and Currie<sup>12</sup> and this can result in either acute or chronic renal failure. In the experimental animal, a

state of acute renal failure, followed very shortly by death, can be produced by massive doses of the parathyroid hormone. Albright *et al.*<sup>2</sup> bring this out in their review of the subject and they state that, although there had been no cases of this in man reported in the literature, they had observed a case which resembled it closely at the Massachusetts General Hospital. Recently, Rogers<sup>29</sup> reported 2 patients with peptic ulcers and unsuspected hyperparathyroidism in whom death from acute renal failure had occurred after a period of moderately severe alkalosis, produced by vigorous ulcer regimens. Here it would seem that the combination of the alkalosis with the pre-existing hyperparathyroidism came very close again to reproducing the picture which Albright describes in the experimental animal.

On the other hand, progression of the renal lesion into chronic renal failure has repeatedly been seen. Mayer<sup>25</sup> reported a case where after removal of the parathyroid tumor in a patient, who had already developed renal calcification, hypertension developed which was terminated by a dissecting aneurysm of the aorta. Johnson<sup>20</sup> described a case where renal insufficiency progressed to such a degree that the three parathyroids that were not involved in the primary adenoma showed the typical changes of secondary hyperparathyroidism.

The differential diagnosis between primary and secondary hyperparathyroidism in a patient with renal insufficiency is often difficult. Shelling and Remsen<sup>32</sup> emphasize the location of the metastatic calcification and state that in general calcification of the kidney represents primary hyperparathyroidism, whereas calcification elsewhere, and sparing the kidney, is suggestive of primary renal disease. However, diffuse renal calcification may occur in renal disease alone and in the absence of parathyroid disease. Albright *et al.*<sup>2</sup> lay more stress on the serum calcium level in distinguishing between the two conditions. Since primary hyperparathyroidism begins with a markedly elevated serum calcium, while that of

renal insufficiency is slightly subnormal, a case with a high calcium should be considered primary parathyroid disease, while that with a low calcium should be regarded as primary renal disease. Castleman and Mallory<sup>11</sup> have described definite histopathological differences between primary and secondary parathyroid hyperplasias, the former being a hyperplasia of a water-clear type of cell and the latter being made up almost entirely of normal size chief cells.

The roentgen picture of the calcified kidneys in hyperparathyroidism is of little help in determining etiology, for the locus of the calcium deposits is apparently not constant. Ettinger and Magendantz<sup>14</sup> present a case in which the kidneys showed "innumerable areas of increased density each about the size of a millet seed lying in wedge-shaped forms conforming to the outlines of the renal pyramids." On the other hand, Brindle and Herrman<sup>9</sup> reported a case where the kidneys were quite diffusely outlined by calcification.

Butler, Wilson and Farber<sup>10</sup> in 1936 called attention to another apparently quite distinct clinical syndrome, associated with calcification of the tubules. They observed 4 infants in whom there was persistent dehydration in the absence of excessive diarrhea or vomiting and in whom there was adequate intake of food and fluid. There was a persistent hyperpnea associated with an increased serum chloride and decreased CO<sub>2</sub>. They also reported the case of a ten year old boy who had similar chemical findings—calcium deposits in the kidney by roentgen examination and a low phosphorus rickets. Albright, Consolazio, Coombs, Hirsh, Sulkowitch and Talbott<sup>3</sup> did extensive metabolic studies on a thirteen year old girl with the same clinical picture.

Neither renal calcification nor rickets is an essential part of the disease. Boyd and Stearns<sup>8</sup> report a case of chronic acidosis and rickets in a patient where the disease process was almost certainly primarily a tubular inability to make an acid urine, but



in whom no renal calcification could be demonstrated. This is good evidence for the impression that renal calcification is secondary in nature, the type of metastatic calcification occurring as a result of local tissue damage. In Butler, Wilson and Farber's infant cases there was no involvement of the bone, attributed by Albright *et al.* to the fact that those cases represented severe and fulminating examples of the disease, in which death occurred before the bone lesions could make their appearance. Baines, Barclay and Cooke<sup>7</sup> recently observed a twenty-nine year old woman who had the typical metabolic findings found in the group of patients but in whom there were again no skeletal changes. Here age was probably the determining factor. These authors emphasize further that it is not essential to postulate the parathyroid mechanism to explain the low serum phosphate concentration, for the chronic acidosis is in itself enough to produce a hyperphosphaturia, which may bring about a lowered serum phosphorus. Haldane has shown that acidosis produced by ammonium chloride will increase phosphorus excretion, and he believes that this hyperphosphaturia is concerned with the buffer action of the urinary phosphates, allowing the kidneys to excrete more acid with less base. Provision of extra base in the diet, in the form of sodium citrate, would offer enough fixed base to the tubular urine so that adequate absorption of phosphates by the tubule could be accomplished. Albright *et al.* conceived of the reversal in serum phosphorus, after correction of the acidosis by the citrate, as being the result of decreased demand for calcium as fixed base, with consequent rise in the serum calcium level which removes the stimulus to parathyroid hyperactivity with subsequently less phosphaturia. It seems logical to believe that both mechanisms are at play.

*Calcification in the Presence of Normal Blood Calcium and Phosphate Levels.* The second type of calcification is found in those diseases of the kidneys in which the renal tissue is necrotic, severely damaged or

chronically inflamed. The name "dystrophic calcification" has been applied to this type of calcification. As mentioned above, the primary factor leading to the deposition of the calcium is probably elevation of the pH due to the decrease in CO<sub>2</sub> production in the devitalized renal tissue. The tuberculous tubule is the example *par excellence* of calcium deposition in areas of necrosis. Calcium is occasionally deposited in tumors and cysts of the kidneys, particularly those in which necrosis and hemorrhage are present. Mercury poisoning with its extensive tubular damage is commonly followed by deposition of calcium in and around damaged renal tubules. More recently calcium has been demonstrated in casts in the renal tubules in certain cases of anuria due to sulfadiazine.

There have been several reported instances of extensive calcification of the kidneys in chronic pyelonephritis. Albright, Dienes and Sulkowitch<sup>4</sup> reported 2 cases in 1938 in which the infecting organism was *H. influenzae*. The blood calcium, phosphorus and proteins were normal, phenol-sulfonphthalein excretion was good, but urinary concentration was only 1.008. On the roentgenogram the calcium deposits were in the pyramids. The patient's history revealed repeated passage of gravel in her urine. This is not a usual symptom in nephrocalcinosis, but may occur when calcium is deposited at the tips of the pyramids where it serves as a nidus for renal calculus formation.<sup>6,28,30</sup> Renal calcification involving the cortex only cannot lead to calculus formation. Wohl<sup>35</sup> reported renal calcification involving chiefly the pyramids in an eleven year old boy whose only symptoms were polydipsia and two times nocturia. He gave a past history of a urethral discharge. Ewell<sup>15</sup> and Grossman and Allyn<sup>18</sup> record 2 further instances of infection leading to calcification, in cases of lower urinary tract obstruction with secondary infection.

Nazari<sup>26</sup> first noted the occurrence of calcification in and around the tubules following prolonged and severe upper gastro-

intestinal obstruction with vomiting. Martz<sup>24</sup> dwelt extensively upon the pathogenesis of these changes and stated that they were due to the marked alkalosis present. According to this concept calcium precipitation results from the continued excretion of acid urine in spite of a systemic alkalosis. With prolonged vomiting, there is a loss not only of chloride, but also of significant quantities of sodium from the stomach. If the sodium loss is great, the blood sodium level may begin to fall. When this occurs, the kidneys attempt to conserve the diminishing supply of the body's base. In order to do this, they must secrete an acid urine, in the face of the alkalosis, instead of the previously alkaline urine elaborated. That the kidneys should not preferentially conserve sodium, whereas the body is even more depleted of chloride, is probably best attributed to the fact that the loss in acid radicals represented by the chloride can be somewhat compensated for by an increase in the bicarbonate content of the blood, while there is no suitable ion to compensate for the sodium loss. Martz feels that strong evidence in favor of this series of electrolytic events is the fact that, when these individuals are given only saline as parenteral fluid therapy, their urines become alkaline again, while the administration of acid salts such as ammonium chloride or calcium chloride only makes them worse. The saline replenishes the sodium needed, whereas the acid salts do not. In any case, the process renders the tubular cell even more alkaline than that afforded it by the alkaline blood serum. A medium is thus produced in which the solubility product constant of calcium phosphate is easily exceeded and precipitation necessarily follows. That this elaborate mechanism is at least not always necessary is brought out by the series of patients studied by Kirsner, Palmer and Humphreys.<sup>21</sup> Their patients were given massive alkali therapy to the point of alkalosis and autopsy findings revealed marked calcium deposition in the collecting tubules. Here the urine had no reason to turn acid, since

there was always excessive base, due to the nature of the production of the alkalosis. In this case the cause of the precipitation must be, to a large extent, based upon concentration of the solutes in the lumina of the distal portion of the tubule, plus the continued alkalosis of the urine in this segment. Both factors tend to precipitate calcium phosphate. Here one would expect to find the calcification within the lumen of the tubule, at least in the very early phase of the lesion, whereas in the case mentioned by Martz, one would expect that the first precipitation would occur within the cell itself. The difficulty of demonstrating this differential point microscopically is in finding an area where the lesion is an early one in which the structure of the surrounding tissues has not been destroyed, for such damage would probably produce further deposition of calcium, which would obscure the original focus.

That these cases of calcification from alkalosis produced by vomiting do not show metastatic calcification elsewhere in the body is also considered by Martz. He suggests that in the lung, where release of CO<sub>2</sub> into the alveoli is a factor in allowing calcium phosphate to precipitate, this factor is no longer at play. In an extreme state of alkalosis the CO<sub>2</sub> is retained through the medium of shallow and slow respirations, in order to conserve bicarbonate to replace lost chloride and cover excessive base. In the stomach, after prolonged vomiting, there is cessation of the production of hydrochloric acid by the gastric mucosa (as shown by Gamble<sup>16</sup>), so that eventually the stomach contents may even become alkaline. Here then the cells are no longer left alkaline by their secretory process and so precipitation of calcium does not occur.

Calcium deposition in renal tissue was produced in rats by Thorn, Clinton, Farber and Edmonds<sup>33</sup> following repeated short exposures to reduced atmospheric pressure. Calcium was deposited between collecting tubules at the corticomedullary junction. It was postulated that these deposits resulted from alkalosis accompanying the

blowing off of carbon dioxide due to hyperventilation stimulated by the anoxia resulting from reduced atmospheric pressure. These authors point out that similar lesions are found in the kidneys of children manifesting hyperpnea from various causes.<sup>10</sup>

#### CASE REPORT

The patient, W. W. (P.B.B.H. No. 10352) a male, aged twenty-six, laborer, was sent to the Peter Bent Brigham Hospital in July, 1943, by Dr. Albert Johnson of Keene, New Hampshire, for an evaluation of his renal status. Dr. Johnson had found, by roentgen examination, extensive calcification of both kidneys. The patient suffered from otitis media of the left ear at the age of ten, but otherwise had enjoyed excellent health until September, 1937. At that time he developed a severe sore throat with chills and high fever. However, he was able to continue doing hard manual labor for one week, when he rested for three days and returned to full time work. Six weeks later dysuria and edema of the face, ankles and legs developed. No gross hematuria was noted. He was placed on a diet of skim milk with no meat or added salt and put to bed for four weeks. Under this regimen, the edema disappeared and he was able to return to work. Shortly thereafter, a tonsillectomy was done because of frequent upper respiratory infections, but the patient continued to have attacks of sore throat. During this time, ankle edema was frequently noted, particularly after a hard day's work. Also, he tired easily, tended to be short of breath, and when tired would occasionally have twitching of muscles and severe muscle cramps. His physician told him that he had hypertension and constant albuminuria and cylindruria. The patient was placed on a diet of 1 to 2 quarts of skim milk daily and of low salt and protein content. During the four months following his initial illness the patient's weight dropped from 191 to 164 pounds, and during the next six years only 3 pounds were regained.

The physical examination at the time of his first admission showed the patient to be a muscular, tall young man in no distress. The temperature was 98.8° F., respirations 20, pulse 80, and blood pressure 196/120. There was no peripheral edema. Examination of the eyegrounds showed slight narrowing of the retinal arterioles. The mucosa of the throat was red and injected. The lungs were negative to auscultation and

percussion. The heart was not enlarged. Rhythm was regular. A Grade 1 systolic murmur was heard over the apex. The aortic second sound was greater than the pulmonic second sound and was of tambour quality. The kidneys were said to be palpable. Reflexes were hyperactive. The remainder of the physical examination revealed nothing of note.

*Laboratory Data.* The blood Hinton test was negative. Examination of the urine showed a persistent++++protein, no sugar and from 0 to few red blood cells and white blood cells per high power field of the sediment in centrifuged specimens. Granular casts were seen in the sediment on one occasion. The hemoglobin was 14.3 grams, red blood cell count was 4,750,000 and white blood cell count was 8,200. The differential count gave 65 per cent polymorphonuclear leukocytes. The blood urea nitrogen was 30, the non-protein nitrogen 45, and the total proteins 4.3. The albumin was 1.6 and globulin 2.7. The fasting blood sugar was 91 mg. per cent. CO<sub>2</sub> was 22.9 mM/l, blood chlorides 108 mEq/l, blood phosphorus 1.5 mM/l, blood calcium 4.6 mEq/l and the alkaline phosphatase was 1.1 Bodansky units. The stool was negative for occult blood. Cultures of the urine were sterile on two occasions, while *Staphylococcus albus* was cultured from one specimen and diphtheroids from another. The phenolsulfonphthalein test showed 10 per cent excretion in fifteen minutes, 40 per cent in two hours with a total volume of 720 cc. The Sulkowicz test was +. The specific gravity of the urine was 1.015 in the overnight concentration test. The blood circulation time, using decholin, was sixteen seconds. Six grams of protein per liter were found in the urine.

The patient was cystoscoped and urine collected which contained no red or white blood cells or casts. Dye injected intravenously appeared in the urine in four minutes, but less than 1 per cent of the dye was excreted in 10 minutes. The electrocardiogram was normal.

Roentgen examination confirmed Dr. Johnson's finding of extensive and uniform finely granular calcification of both kidneys (Fig. 1). No calculi could be identified in the kidneys, ureters or bladder. Retrograde pyelograms revealed normal renal pelvises and calices distinctly visible through the overlying calcification. The kidneys measured:—right 14.0 by 6.5 cm., left 14.0 by 6.2 cm. on the roentgenograms. The bones of the pelvis, spine, chest and skull showed the normal bone detail and calcium

content of a young man, with no osteoporosis or cyst formation. There was no cardiac enlargement, in fact the heart was 15 per cent below the predicted average according to Ungerleider's height-weight chart.<sup>34</sup> The lungs were clear (Fig. 2). The skull and sella turcica were normal. There was marked calcification of the larger pelvic arteries at this time.

*Hospital Course.* Fluids were forced to 3,000 cc. daily and the patient given 100–125 gm. of protein each day. Calcium intake was limited to 0.5 gm. per day.

He was discharged on the twentieth hospital day with no change in his renal status.

The patient returned to the hospital in January, 1945, one and one-half years later, because of itching of the skin of eight weeks' duration. Following his first discharge he had felt well until the onset of the itching. However, one year before the second admission he had an attack of left otitis media with perforation. The patient continued to have peripheral edema but at no time noticed hematuria or headaches. Ten weeks before entering the hospital the patient suffered from frequent nausea and vomiting and because of these symptoms the fluid

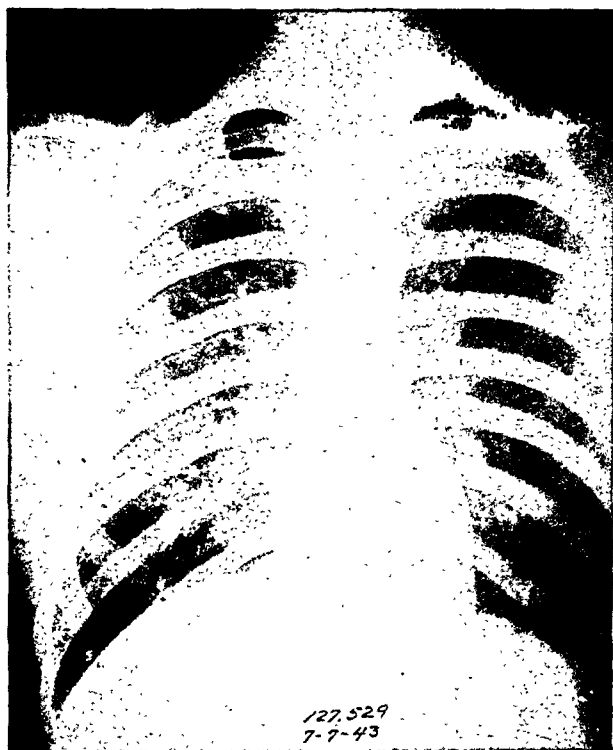


FIG. 2. Seven foot roentgenogram of the heart, July 7, 1943. Patient's measurements were: height 6 feet 1 inch; weight 167 pounds; predicted transverse diameter 128 mm.; measured transverse diameter 109 mm.

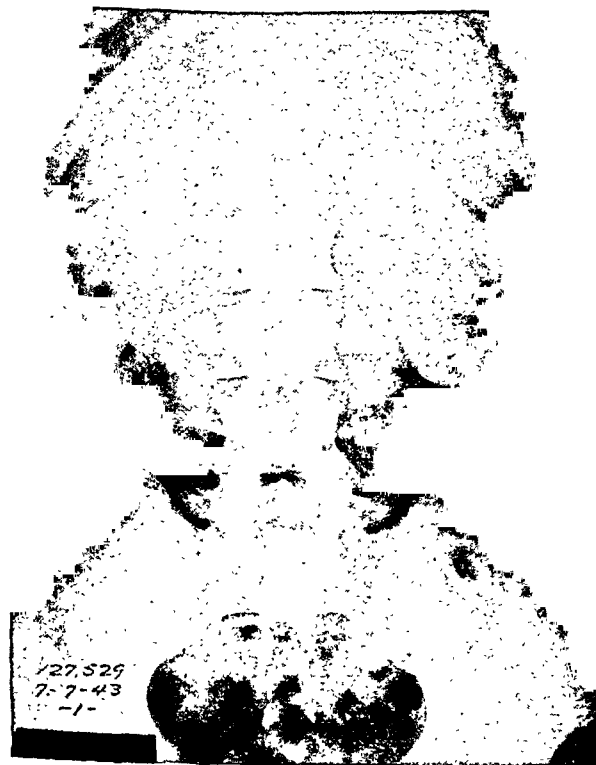


FIG. 1. Plain roentgenogram of the kidneys, July 7, 1943, showing marked calcification of both kidneys particularly in the cortices. Kidney measurements given in text.

intake and food ingestion was low. At the time the skin began to itch, a rash, made up of small papular or pustular lesions, appeared. These lesions would break open and be followed by scabbing and scar formation.

At the time of the second admission the temperature was 98.4° F., pulse 90, respirations 24 and blood pressure 200/120. The skin was dry and "sallow." There were numerous papules over the body, many of which were scarred and surrounded by areas of pigmentation. Examination of the fundi showed some narrowing of the arterioles but no exudate or hemorrhages. The left ear drum was perforated and a small amount of exudate was present. The heart was slightly enlarged to percussion and a Grade II systolic murmur was heard over the precordium. The lungs were clear to auscultation and percussion. Examination of the abdomen was negative. Edema was demonstrated over the sacrum and left ankle.

*Laboratory Data.* The urine was pale yellow and cloudy. The pH ranged between 5.5 and 6.0. The specific gravity varied between 1.010 and 1.012. There was ++++ albuminuria. Red blood cells averaged 20 to 30 and white

blood cells 6 to 10 per high power field. There were many granular and fatty casts. The hematocrit was 22 and fell to 18 terminally, repeated white blood cell counts were in the 6,000 to 8,000 range and the differentiated counts were normal. The blood sedimentation rate was 2.4 mm/min. At the time of admission the blood urea nitrogen was 177 mg. per cent,

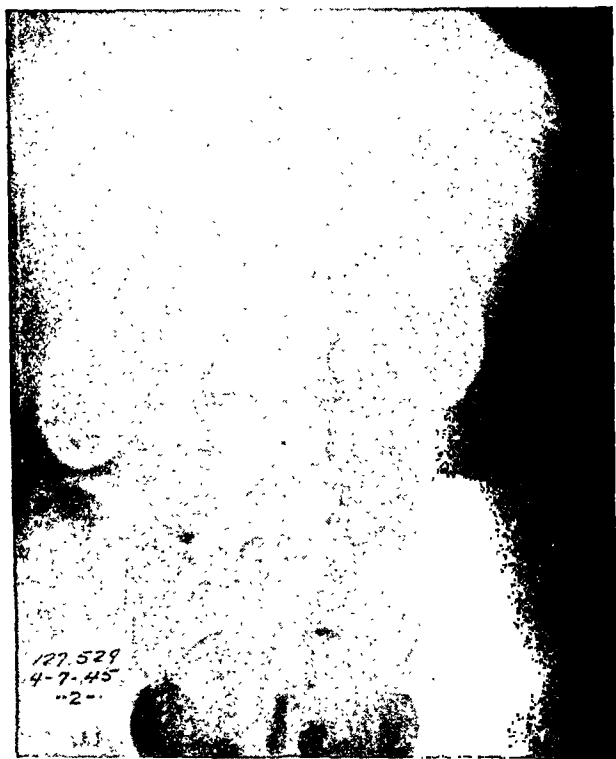


FIG. 3. Plain roentgenogram of the kidneys, April 7, 1945. Note decrease in size of the kidneys. Right kidney is depressed by the enlarged liver and rotated on the horizontal axis. Kidney measurements given in text.

non-protein nitrogen 229 mg. per cent, total protein 7.2 gm. per cent,  $\text{CO}_2$  17.8 mM/l and chlorides 96 mEq/l. Blood phosphatase was 0.8 Bodansky units, blood calcium 4.3 and blood phosphorus 5.6 mEq/l. The circulation time was 15 sec., the vital capacity 2,500 cc., basal metabolic rate -5 per cent. Ketosteroids excretion was 4.3 mg. in twenty-four hours. The standard urea clearance test showed 6 per cent excretion in one hour. The electrocardiograms showed T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> to be flat with a normal lead IV.

Re-examination by roentgen ray revealed the uniform finely granular calcification of both kidneys, apparently the same in type and degree as at first examination, but the kidneys had decreased in size, now measuring: right

10.5 by 5.5 cm., left 12.0 by 5.3 cm.\* The roentgenograms were taken with the same technique used eighteen months earlier (Fig. 3). The heart had increased in size, now measuring 4 per cent above the predicted average for the patient's height and weight. All of the visualized bones again were of normal texture and appearance, with normal calcium content for a man of his age. No calculi could be identified. The lungs were clear. Later roentgen examinations revealed progressive terminal enlargement of the heart, pulmonary congestion and hydrothorax and a probable pericardial effusion.

*Hospital Course.* The patient was placed on a moderate salt, high caloric, 80 gram protein alkaline-ash diet. Therapy consisted of four blood transfusions, parenteral hypertonic saline and glucose, forced fluids, vitamins, iron and creamalin. The itching of the skin persisted and one of the pustular lesions was removed for study. Microscopic sections showed scarring and lymphocytic infiltration of the subcutaneous tissue with calcium deposition. Following therapy the edema increased and the patient was digitalized in an effort to improve his circulatory status. Southey tubes were used with some initial success but with eventual failure in relieving the edema. Four weeks before death a pericardial friction rub developed which persisted until death. The blood urea nitrogen fell to 72 mg. per cent in the first few days and gradually rose to 135 mg. per cent, the  $\text{CO}_2$  rose to 25.6 mEq/l and then fell to 16. Chlorides gradually dropped to 76 mEq/l. The patient developed acidosis, air hunger, became disoriented and died on the 108th hospital day with cessation of respiration followed by stopping of the heart.

*Autopsy Findings* (P.B.B.H. No. A-45-77). The body was that of a normally developed and nourished white male. The appearance was that of a sthenic, muscular individual who appeared older than the stated age of twenty-eight. The skin was dry and green-brown in color. Papular lesions were present over the face, neck and chest and to a lesser degree the back, abdomen and extremities. The lesions were firm, slightly raised, with grey edges and brown centers which were frequently encrusted or ulcerated. They measured approximately 5 mm. in diameter. Histopathological examination of one of these

\* The right kidney measurements are not reliable as the kidney was depressed by the enlarged liver. At autopsy five weeks later, the kidneys measured: right 11.0 by 5.9 cm., left 10.5 by 5.4 cm.

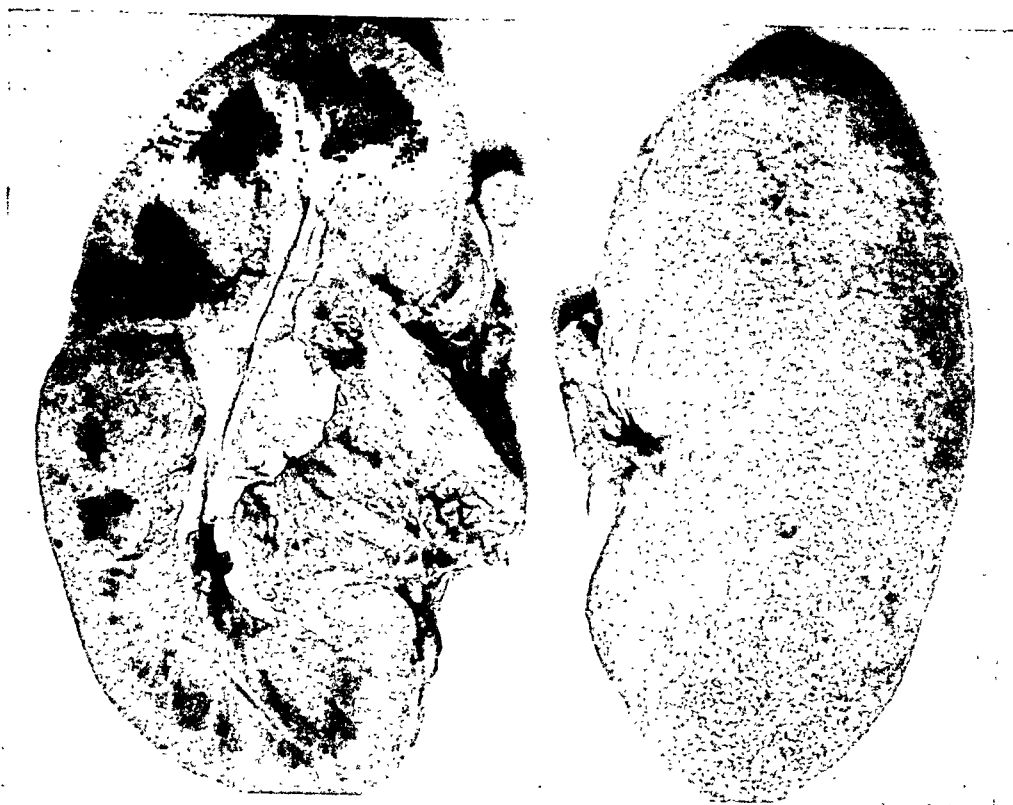


FIG. 4. Gross appearance of the kidneys at autopsy. The small white calcified nodules can best be seen scattered throughout the cut surface of the cortex.

lesions showed moderate hyperkeratosis of the epidermis which was lightly infiltrated by polymorphonuclear cells. The epidermis extended downward into the cutis and several segments were detached and surrounded by dense fibrous tissue which was sparsely infiltrated by lymphocytes. Keratinization with pearl formation was noted in some of the epidermoid projections and calcium was found in one of the pearls. There was marked pitting edema extending from the feet upward to the thighs.

The parietal and visceral surfaces of the pericardium were covered by a grey, shaggy fibrinous exudate. The heart weighed 790 grams. The left and right ventricles were markedly enlarged and their walls measured 2.4 cm. and 0.5 cm. in thickness respectively. No valvular or myocardial lesions were found and there was no evidence of calcium deposition. The right lung weighed 800 grams and the left lung 700 grams. Considerable frothy, clear, blood-tinged fluid could be expressed from the cut surfaces and microscopic examination demonstrated marked pulmonary congestion and edema. No calcium was found. There was 400 cc. of clear thin amber-colored fluid in the right thorax.

The liver weighed 2,700 grams and the gross and histopathological findings were those of marked chronic passive congestion.

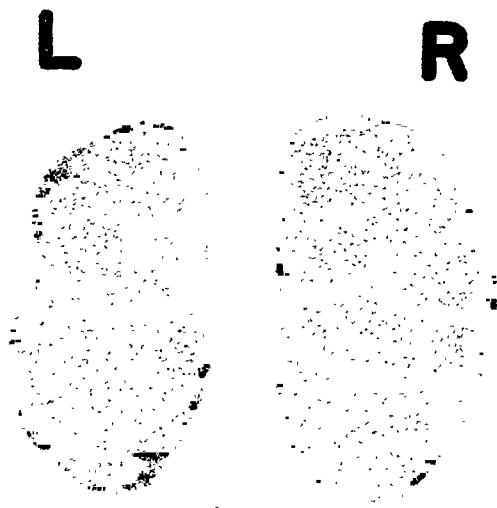


FIG. 5. Roentgenogram of excised kidneys after autopsy. Note the fine granular calcification, most marked in the cortices faintly outlining the kidney lobules.

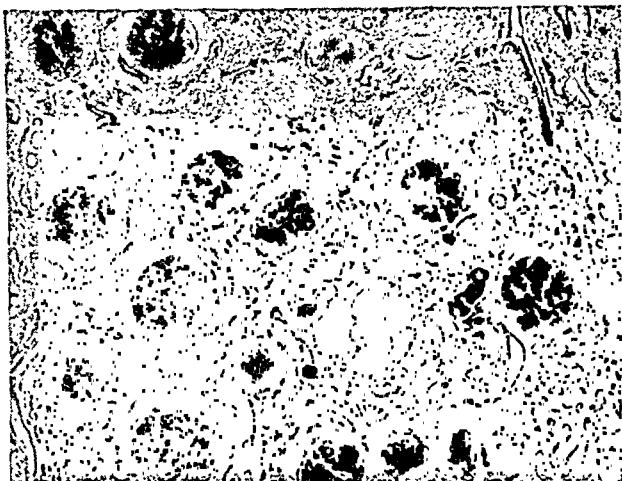


FIG. 6. Low power photomicrograph showing the nature of the renal damage.

The right kidney weighed 160 grams and the left weighed 180 grams. The kidneys were similar in appearance and are described together. The renal capsules were slightly thickened and stripped with difficulty, exposing a uniform and finely granular, pale brown surface. Cut sections showed the cortex to be well demarcated from the medulla and to measure from 6–7 mm. in width. The most striking finding was diffuse finely nodular calcification throughout the cortex, which imparted to the cortex a sandpaper-like quality as the examining finger was rubbed across the kidney. When the kidneys were cut, a gritty sensation was observed. Innumerable small calcified granules measuring from 1 to 2 mm. in diameter were found throughout the cortex (Fig. 4 and 5). These could be scraped free of the cut surfaces leaving small smooth-walled pits. These granules were grey-white and semitranslucent. The medulla was free from calcification. The tubular striations could be identified and the papillae were pointed. There was moderate thickening of the walls of the pelvic vessels. The calices, pelves and ureters were not remarkable and were free from calcification and calculi (Fig. 4).

Representative blocks of kidneys were fixed in Zenker's acid solution and 10 per cent formalin. Sections were stained with eosin-methylene blue, hematoxylin eosin, Mallory's phosphotungstic acid, Mallory's aniline blue, and Kossa's silver stains. The glomeruli were severely damaged. Large numbers were completely hyalinized. The basement membranes of many other glomeruli were thickened by hyalinized connective tissue and these glomeruli

appeared atrophic and bloodless (Fig. 6). Still other glomerular tufts were prominent due to increase in cellularity and a few polymorphonuclear leukocytes were present in the involved tufts. The capsular epithelium was often cuboidal or proliferating and "crescent" formation was common.

The most striking histopathological finding was the presence of completely or partially calcified bodies throughout both the convoluted and collecting tubules of the cortex (Fig. 7). These bodies gave a positive reaction for calcium when stained with Kossa's silver stain. These were roughly the shape of the dilated tubules in which they were found. Those casts that were incompletely calcified were pale, amorphous and acidophilic. Occasionally remnants of flattened tubular cells were found lining the tubules containing the casts but in most instances the lining epithelium was absent. Rarely calcified bodies were found beneath the tubular epithelium but here the arrangement of the epithelium was such as to suggest that the epithelium had regenerated over the calcified material.

No calcified bodies were noted in the pyramidal tubules. The cortical tubules without casts were dilated and lined by flattened epithelium. Occasionally polymorphonuclear leukocytes, red blood cells and precipitated protein were present in the pyramidal tubules. There was a moderate increase in interstitial tissue with definite increase in fibrous tissue. This was particularly marked about fibrosed glomeruli. Here, too, was diffuse lymphocytic infiltration.

There was definite hyaline thickening of the

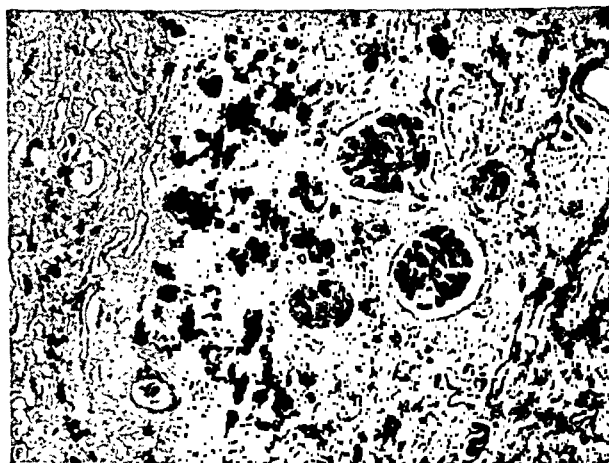


FIG. 7. Kossa's silver stain for calcium illustrating the marked calcium deposition in the cortical tubules.



walls of the arterioles and intimal and medial proliferation and thickening of the small and medium-sized arteries. In addition, occasional arterioles were found in which there was definite hyperplastic proliferation of the intima.

The parathyroid glands were homogeneous and light pink-brown in color. Section showed marked increase in cellularity with almost total disappearance of fat tissue. Chief cells were by far the most abundant. These cells were polygonal with pale cytoplasm and the nuclei were round and regular. No adenomas were found.

The adrenal and thyroid glands were not remarkable.

There were no gross alterations in the skeletal system, nor was any change noted in the bony pattern of the vertebral and femoral marrow. There was no calcification of any of the blood vessels examined.

Permission for examination of the brain was denied and the pituitary gland was not examined.

*Anatomical Diagnoses:* Chronic glomerulonephritis, severe; calcinosis of skin and kidneys; parathyroid hyperplasia, secondary; fibrinous pericarditis; hypertensive heart disease; pulmonary congestion and edema; hydrothorax, right; chronic passive congestion of viscera.

#### DISCUSSION

So far as could be ascertained in reviewing the literature, this case is unique. To summarize, the problem was that of a patient who, six years prior to first being seen in this hospital, suffered from a streptococcal throat followed by what appears to have been a typical acute glomerulonephritis. During the acute stage of his renal disease the patient was placed on a high milk diet, which was maintained for the following six years, during which time he continued hard manual labor. At the end of this time, because of the gradual onset of symptoms of renal insufficiency, a roentgenogram was taken of his kidneys and the extraordinarily extensive calcification was found. The next two years, the period during which he was observed in this hospital, were characterized by progressive decline with the development of terminal uremia, a course similar to that commonly seen in chronic glomerulonephritis. So far as could

be determined, the presence of the calcium in the kidney was no more than a contributing factor in the production of the renal insufficiency. The striking calcification of the kidneys revealed by roentgen examination could easily be differentiated from that usually seen in hyperparathyroidism where actual calculi are found in the renal pelves and calices, but not from the metastatic calcification which could be the result of an unusual degree of hyperparathyroid activity as described by Albright *et al.*<sup>2</sup> The normal bone detail, however, was considered to be evidence against this hypothesis. Calcification due to tuberculosis also appears quite different, having an amorphous appearance, usually grossly lobulated and as a rule limited to one side when as extensive as in this case. Calcification in renal tumors, vascular anomalies, infarcts, etc., could be ruled out by the uniformity and symmetry of the calcium deposits. In fact, the appearance by roentgen ray was unique in our experience, and could be attributed only to some disease or injury uniformly involving all of the renal tissue.

The fact that the heart measurements were below normal at first and only 4 per cent above average four months before death, when at autopsy the heart weighed 790 grams, was disturbing to say the least, and proves again that heart measurements falling within the normal range may not exclude a considerable degree of cardiac hypertrophy. Of course, it is also true that the weight of a heart at autopsy is not a reliable index of the size of that heart during life, if dilatation has been present, but that was not the problem in this case.

There was no evidence that would put this case into any of the groups characterized by extensive renal calcification, which were discussed earlier. Positive evidence against hyperparathyroidism was the normal blood calcium and phosphorus levels which were present when first seen. It is to be emphasized that at this time the renal calcification was already as extensive as it was ever to become. Repeated cultures of



the urine revealed either nonspecific contaminants or were sterile, and the urinalyses, symptomatology, course and autopsy findings lent further evidence to the fact that renal infection played no part in the pathogenesis of the calcification. The specific dysfunction of the tubules associated with calcification, as described by Albright, Consolazio, Coombs, Hirsh, Sulkowitch and Talbott, is likewise ruled out by lack of the specific blood chemical changes that characterize this syndrome.

It is suggested that the following series of events were productive of the renal changes observed. Early in the disease, when there was still active inflammation in the renal parenchyma, the patient consumed enormous quantities of milk, so that necessarily large amounts of calcium were excreted in the urine. Under normal circumstances a calcium intake of this degree can be responsible for such high concentrations of calcium in the urine that precipitation may occur and renal stones be formed. In this instance there was at the time of hypercalcinuria active degeneration of renal tissue creating a medium in which precipitation would be likely to take place. That the distal convoluted and collecting tubules should be the site of this precipitation is to be expected, as it is in these areas that the urine is finally concentrated to the point where the calcium concentration might be expected to be at or above the level of saturation. It should be noted that we feel that there were two separate and distinct processes at work, the one being the result of the other. The first was the occurrence of an acute nephritis, which subsided into a subacute or latent phase, and which eventually was responsible for such scarring that a state of renal insufficiency resulted. The second was the laying down of calcium in the damaged renal tissue. This probably was the work of years of high urinary concentrations of calcium, with concomitant smouldering renal activity providing the tissue damage. The added insult of the calcium deposition in the kidneys may have contributed to the renal

failure, but it was certainly not the prime factor.

Because the vague reports of early alkali therapy could not be substantiated in a review of this patient's case history, this explanation of the pathogenesis of the renal calcification has been given only passing mention. However, if such were actually the case and this man did receive large amounts of alkali at the time that he suffered his original acute renal damage, or shortly thereafter, then the elevated urinary pH would tend to precipitate the calcium in the renal parenchyma.

#### SUMMARY

1. The subject of nephrocalcinosis is reviewed and the pathological and physiological processes are discussed.
2. A case of glomerulonephritis with extensive calcium deposition is presented and the contributing physiological phenomena are considered.

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# THE SIGNIFICANCE OF INDENTURES IN THE OUTLINES OF THE ATRIA OF THE LATERAL VENTRICLES AFTER AIR FILLING

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AFTER encephalography or ventriculography there may be visualized one or two indentures unilaterally or bilaterally in the atrial regions (the junction of the body with the temporal and occipital horns) of the lateral ventricles. The first or more rostral indenture or defect is known as the glomus indenture and the second in the caudal margin of the atrium of the ventricle is known as the calcar avis indenture.

It is the purpose of this paper to explain the significance of these indentures and to differentiate the normal from the pathological.

## I. GLOMUS INDENTURE

The first indenture or defect occurs in the lower wall, just rostral to the subdivision of the lateral ventricular body into an occipital and a temporal horn (atrial



FIG. 1. Two calcified portions of the choroid plexus are seen at *a*. (From Pancoast, Pendergrass, and Schaeffer. *The Head and Neck in Roentgen Diagnosis*.)<sup>5</sup>

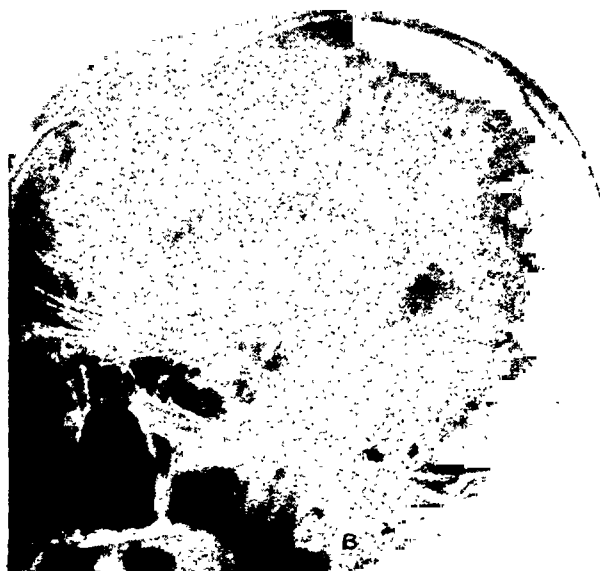
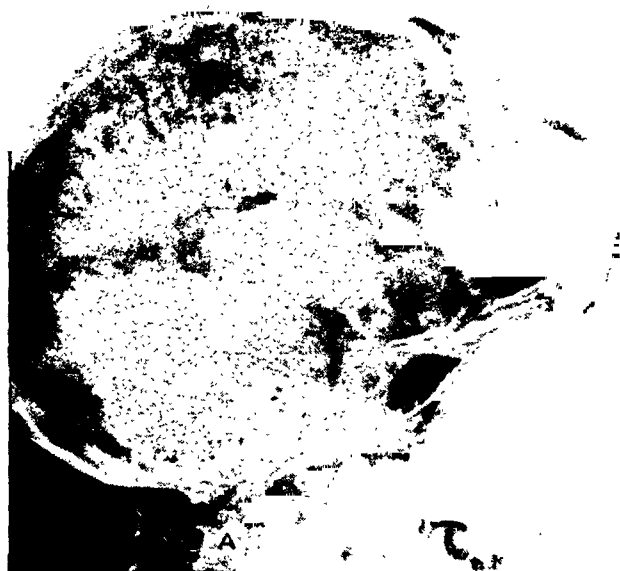


FIG. 2. Demonstrating asymmetry of the posterior horns on the same patient. *A*, large posterior horn on one side and *B*, a very small posterior horn on the contralateral side.

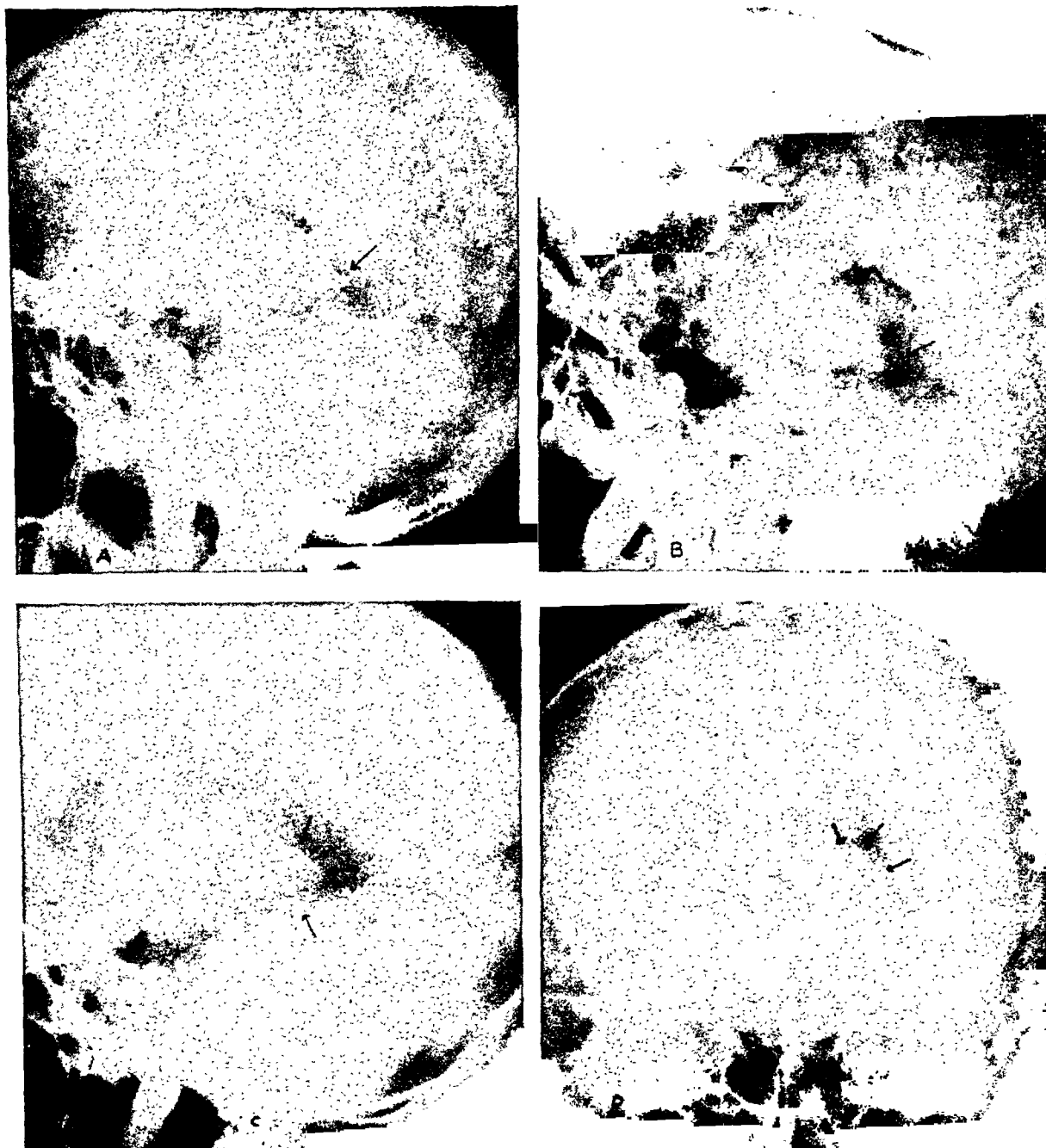


FIG. 3. *A*, small glomus defect. *B*, moderate sized glomus defect. *C*, large normal sized glomus defect. *D*, same case as *C* in the sagittal view.

region), and is known as a glomus indenture. It is produced by the upward and backward projection of the choroid plexus as it makes a sharp turn from its position in the floor of the lateral ventricle (between the basal ganglia and the thalami) and follows the ventricle around the pulvinar into the inferior horn. The portion of the plexus where the bend occurs forms a globular mass which is called the glomus. Here the

plexus tissue is more abundant and is the region where calcifications may occur. Dyke found an incidence of glomus calcifications in 5.1 per cent of individuals.

For measurement purposes the lateral views are utilized. The glomus shadow, however, may also be seen in the sagittal views in the lower and medial aspect of the atrium.

When the glomus shadow itself is small

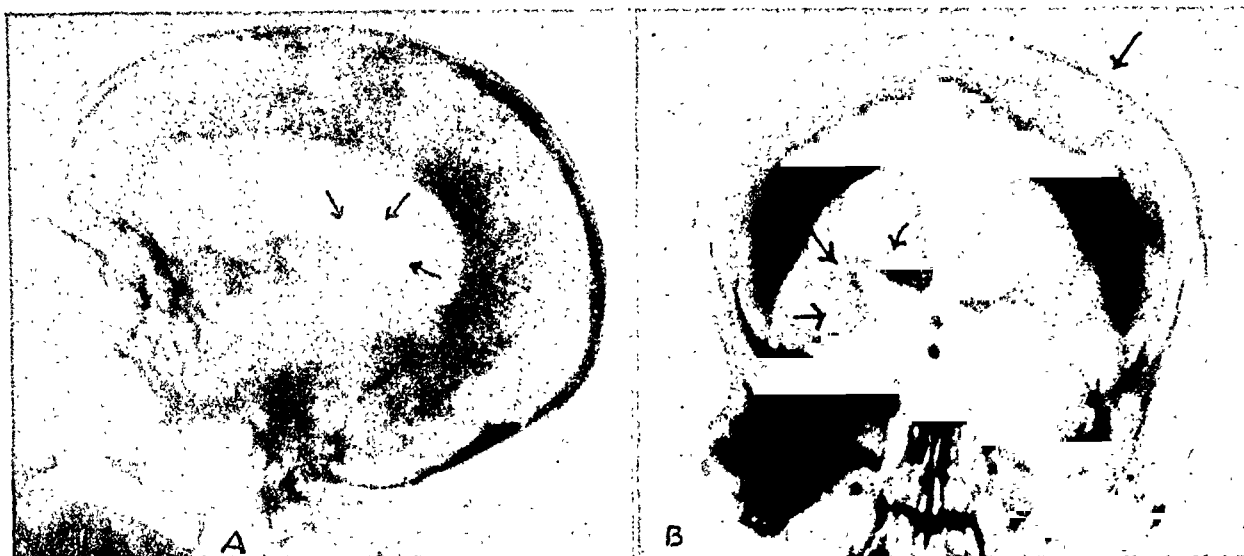


FIG. 4. Large abnormal glomus defect measuring 700 sq. mm. present on the side contralateral to the trephine opening for ventriculography and due to cysts of the glomus choroid. *A*, in the lateral view and *B*, in the sagittal view.

or absent, it may occasionally be possible to visualize in the sagittal views the portion of the choroid plexus just rostral to the glomus as it lies in the floor of the lateral ventricle. It projects up into the lumen of the ventricle, demarcating the thalamus

which is lateral, from the body of the fornix, which is medial.

Dyke and Davidoff's average measurement of the defect produced by the glomus in the lateral horizontal views was 60 sq. mm. The maximum measurements they

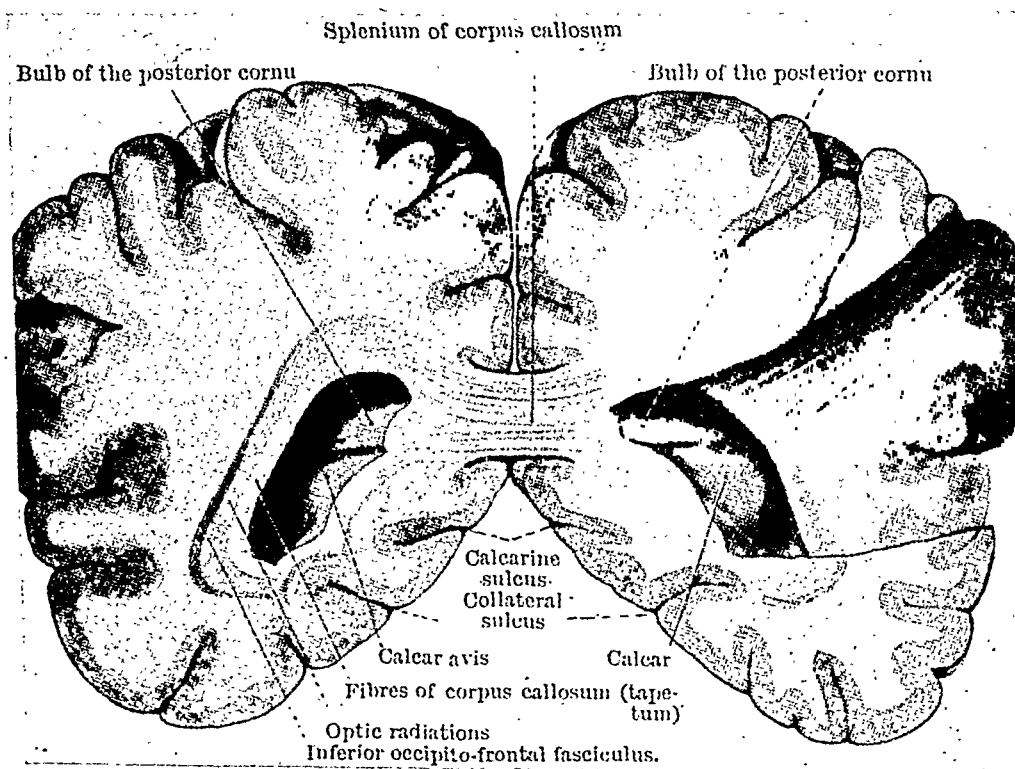


FIG. 5. Frontal section through the posterior horns of the lateral ventricles viewed from the front. (From Cunningham's Textbook of Anatomy, revised fifth edition.)<sup>4</sup>

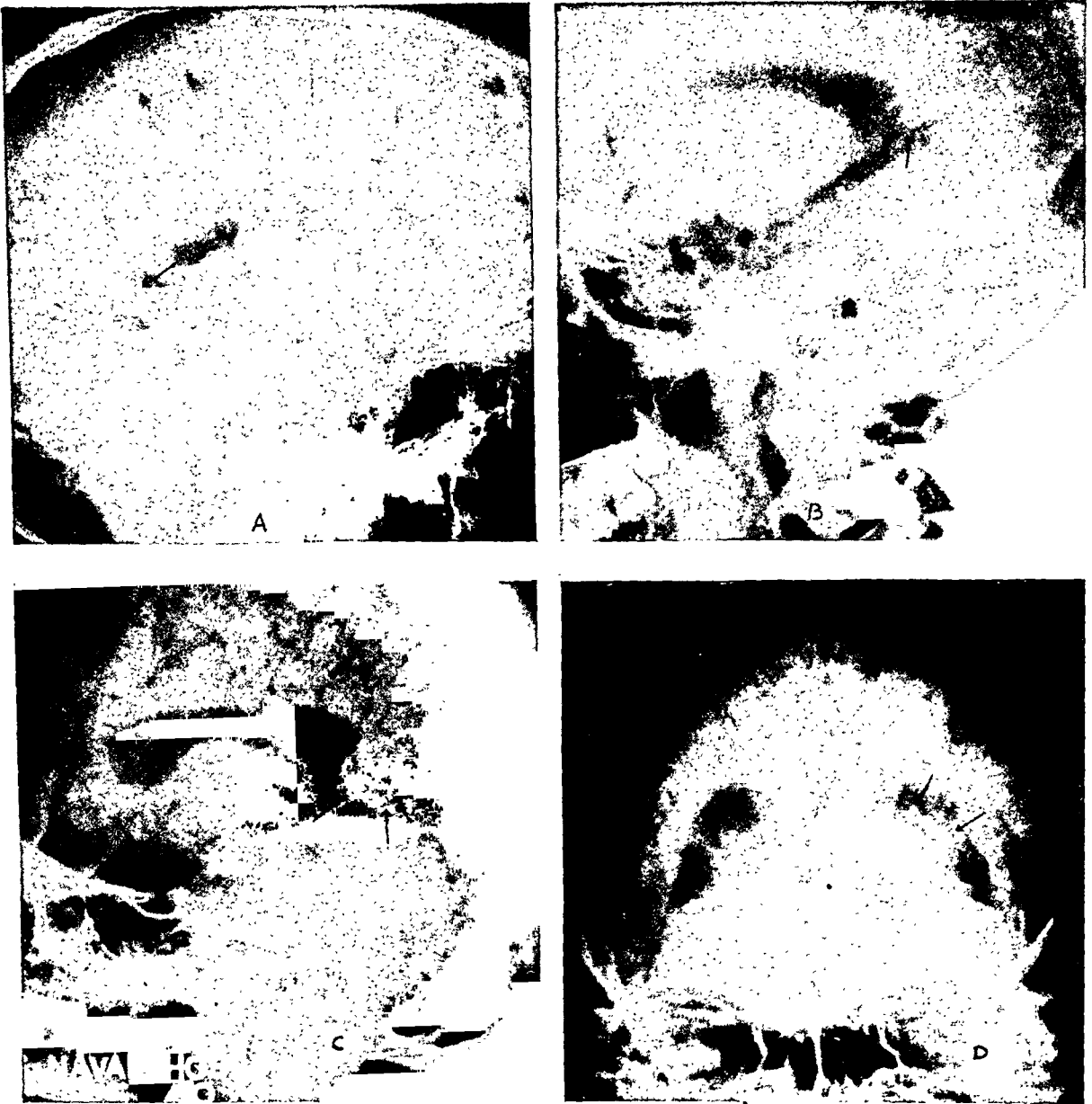


FIG. 6. Calcar avis defects. *A*, moderate sized; *B*, slightly larger than *A*; *C*, very large, measuring 381 sq. mm.; *D*, same case as *C* seen in the sagittal view.

considered within normal limits were 15 by 15 mm. (225 sq. mm.)

In 1935, Dyke, Elsberg and Davidoff demonstrated the following: (1) That "During the puncture of the ventricles in the posterior parietal region for the introduction of air, as ordinarily done, the brain cannula may accidentally come into contact with and traumatize the glomus of the choroid plexus or a vessel in the wall of the ventricle. This may produce a hematoma or edema . . . which can be recognized on

the roentgen films as a defect in the outline of the lower wall of the lateral ventricle situated in or near the position of the glomus." (2) That "this enlarged defect was never produced if encephalography was done." (3) That "Whenever doubt exists as to whether the defect is due to a traumatic lesion or to some other cause, encephalography may be done a week later to clarify the point, for a traumatic lesion will then have largely disappeared." (4) That "in one case, an enlarged defect on the side

contralateral to the ventricular puncture was proven to be due to retention cysts of the glomus of the choroid plexus as shown at necropsy."

In 1938, one of the authors (M.H.P.) recorded a second case of an enlarged glomus defect (700 sq. mm.) present contralateral to the side of ventricular puncture and due to cysts of the glomus.

From a pathological viewpoint, enlarged glomus shadows may also be caused by benign hypertrophy or by other tumors of the choroid plexus, or of the neighboring ventricular wall.

## 2. CALCAR AVIS INDENTURE

The second indenture or defect is known as the calcar avis defect (hippocampus minor) and is produced by an invagination of the ventricular wall in the region of the junction between the atrium and the occipital horn on the medial and slightly on the dorsal aspect of this portion of the ventricle. The invagination results from a deep projection, laterally, of the calcarine fissure which causes the fibers of the posterior forceps to detour around it, thus producing a projection or elevation into the ventricle in this region. In the course of development, the visual receptive area striata becomes folded along its axis during the sixth month, and the furrow thus formed is called the calcarine fissure. The name was applied to the fissure by Huxley because its deep anterior part indents the whole thickness of the medial wall of the hemisphere, and the swelling so produced was supposed by the older anatomists to resemble a cock's spur and was hence called calcar avis.

The indenture representing the calcar avis varies greatly in size. In some, it is absent or else shallow and insignificant. It

is not necessarily the same size on both sides. It may be greatly enlarged unilaterally, and normal or absent on the contralateral side. When large, it will be found that the occipital horn is correspondingly small or absent as the size and shape of the occipital horn is dependent to a considerable extent upon the development of the calcar avis and the forceps major. Infrequently, the forceps and the calcar avis produce a distinct notch in the rostral portion of the occipital horn.

We have found the notch to average about 50 sq. mm. in the lateral roentgenograms when present. The largest normal one encountered measured 381 sq. mm. Care must be exercised not to regard this indenture as pathological but to classify it as a variation in the normal.

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# CRANIAL MANIFESTATIONS OF FIBROUS DYSPLASIA OF BONE

## THEIR RELATION TO LEONTIASIS OSSEA AND TO SIMPLE BONE CYSTS OF THE VAULT\*

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**N**UMEROUS contributions to the knowledge of polyostotic fibrous dysplasia have established the fact that the skull is frequently involved in this disorder. Skull changes are often the only manifestations of the disease.

Morphological and roentgenological abnormalities in the bones of the skull are diverse. These range from small, simple translucencies and blister-like bone cysts which may be sharply outlined, rounded, or irregular in contour and measure only 2 to 3 cm. in diameter, to more extensive involvement of the calvarium and bones of the face. In rare extreme cases, intense exuberance of massive bone deposits may cause diffuse thickening of the calvarium as much as 2 to 3 cm. It may also obliterate the structures of the base of the skull, and extension of the disease into the bones of the orbit and sinuses may transform the entire skull into an almost shapeless mass. Since the end of the last century such cases have been frequently described as leontiasis ossea.

Despite the great variety of cranial manifestations accompanying fibrous dysplasia, clinical and pathological evidence is sufficiently coordinated to warrant primary investigation of the bones of the skull and face irrespective of known widespread skeletal involvement. Occasionally, skull changes are the first and only tangible evidence of this generalized disorder; misinterpretation may obscure the true diagnosis and lead to ineffective or harmful treatment. Pathological reactions of membranous bones differ from those of other types; in the skull, bone destruction and osteogenesis underlie different effects of static

and dynamic influences from those in other bones.

Skull changes of fibrous dysplasia demonstrated roentgenologically do not always correspond to those in other parts of the skeleton, where broadening of the bone, thinning of the cortex, and a rarefied, trabeculated appearance of the spongy structure gives the impression of cyst formation. In contrast to these skeletal changes, there is a tendency toward formation of sclerotic, dense bony deposits in moderately advanced and severe cases. This is most marked when the disease extends to the base of the skull, paranasal sinuses, or the nasal cavity.

### LIMITED INVOLVEMENT OF THE SKULL

Roentgenologically, at this stage the foci of the disease resemble simple, rounded, cyst-like translucencies of the vault, with widening of the diploe, loss of bone tissue, and thinning of the tables. These cysts may either protrude beyond the outer table, or remain level with its surface. This depends upon the extent to which the bone has expanded due to connective proliferation. Their appearance may not change during many years of observation. Frequently, they are localized in the occipital squama, but may be observed in the parietal and frontal bones as well. The cyst margins are dense, and usually faint bone spicules are seen within the cystic area. In none of our cases did the cysts pass through sutures. Thus, in accordance with the skeletal classification of the disease, they may be considered as a monostotic localization of

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fibrous dysplasia. Only once in our group of cases were skeletal changes present. No biochemical abnormalities were observed in two examined instances. No clinical signs were observed which could have been caused by the changes of the cranial vault.

#### MODERATE CRANIAL INVOLVEMENT

In most patients presenting moderate cranial involvement, development of the

skeletal involvement. This finding is of diagnostic value, not only in the classification of cases under observation but also in the evaluation of old records in which the disease was described under a variety of terms. Bone cysts and deformities of long bones are present in about one-half of the cases and pigmentation of the skin and precocious puberty in females in about one-third.



FIG. 1. *A*, one year old girl in perfect health. Small lump on right side of skull. Roentgen examination: Rounded translucency in right temporoparietal area measuring about  $2 \times 2$  cm. Borders dense. Faint bone lamellae within density. Operation: Firm, white, brittle connective structures with small bone spicules in area of translucency. Microscopical: Dense connective tissue bounded by bony trabecula replacing bone marrow. Fibroblast-like cells arranged in whorling trabecula. Intercellular material of reticulocollagenous type. Final diagnosis: Fibrous dysplasia.

*B*, rounded translucency on posterior portion of temporal squama protruding on outer table. Faint bony spicules within translucency and dense bone margin surrounding translucent areas. Case studied and filed as osteitis fibrosa cystica of the skull. Normal structure of bones of calvarium. No signs of hyperparathyroidism. Roentgen diagnosis: Fibrous dysplasia. In observation for six years.

disease dates from early childhood. Already at that time deformity of the calvarium or face is evident. Areas are larger than in the stage of limited involvement. The outlines of the cranium and face are often seriously distorted. The more widespread the skeletal distribution, the more frequent and extensive the skull involvement. At this stage certain characteristic features may be most clearly recognized. First is the remarkable unilateral localization of abnormalities of the skull and facial bones. This is usually homologous to the side of the

At this stage, too, new bone formation often becomes evident; this appears on the roentgenogram as either rounded densities, irregular islands or spicules surrounded by more or less extensive translucencies.

#### SEVERE CRANIAL INVOLVEMENT; LEONTIASIS OSSEA (FIBRODYSPLASTIC TYPE)

All severe cases of fibrous dysplasia of bone reveal changes in the skull. In extensive involvement of the skeleton, skull changes are correspondingly serious. The circumscribed cystic expansion of the outer

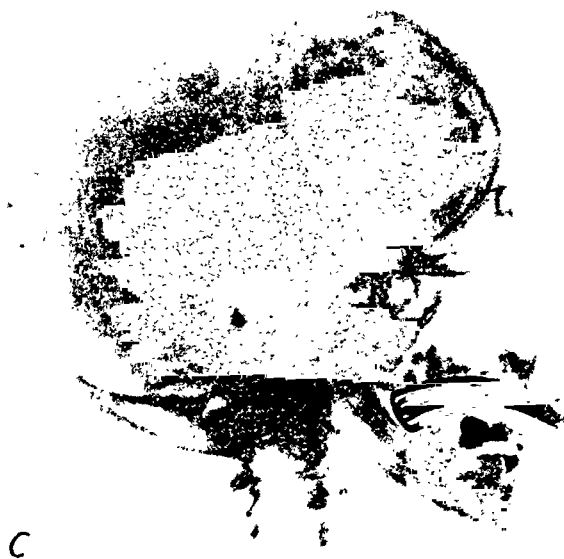
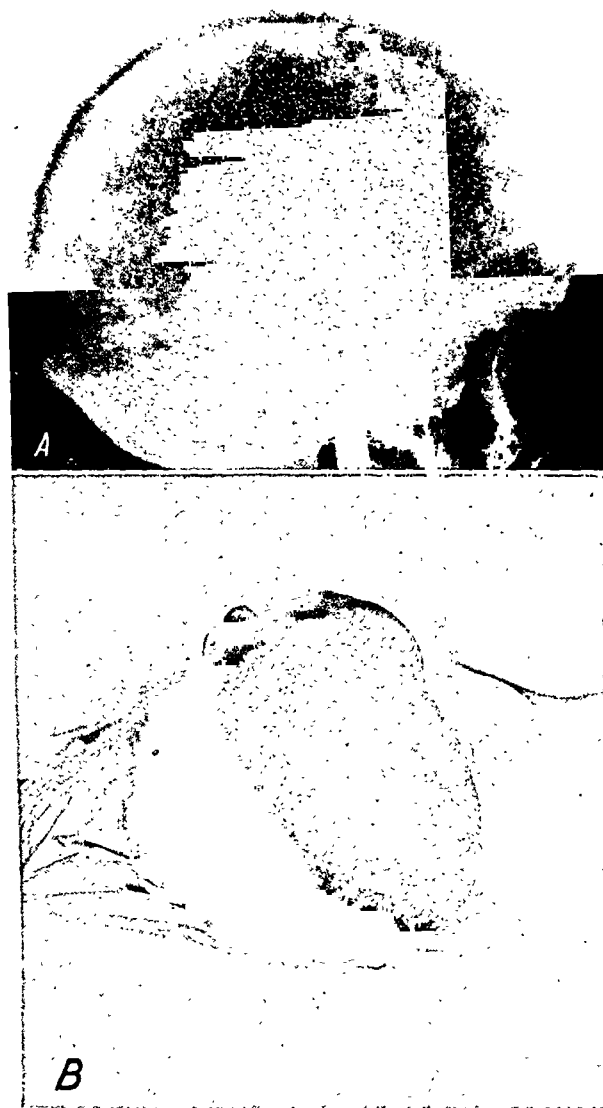


FIG. 2. *A*, twenty-two year old sailor with numerous cysts in long bones and pelvis; No skeletal decalcification. Normal blood chemistry. Note irregular translucencies and sharply outlined densities in frontal squama and parietal bones. Denser bony deposits on the floor of the anterior and of the middle fossa. Fibrous dysplasia, moderate cranial involvement. (Courtesy of Dr. Leef.)

*B*, photograph of cranium of forty-one year old woman with hard, bony protuberance on frontoparietal area since childhood.

*C*, (same case as Fig. 2 *B*.) Outer table of right frontal bone elevated over area of 8 x 8 x 2 cm. Note translucencies and numerous small irregular masses of ossification. Inner table of frontal bone and roof of the orbit irregular. Case diagnosed roent-

genologically: Meningioma. Histopathologically: Fibrous dysplasia.

FIG. 3. Massive bony deposits on outer and inner tables of frontal squama and roof of orbits. Considerable thickening of anterior clinoids and translucencies in frontoparietal area. Diagnosis: Fibrous dysplasia. (Observed for eight years.)



table is not similarly pronounced. The deformity is usually not delimited; larger areas, and occasionally the whole skull, may become involved. Extensive translucencies may occur, often largely filled by irregular, sclerotic islands and dense spicules, and the entire cranium may be considerably deformed. New-formed bone masses may be deposited on the calvarium and base of the skull, especially about the



FIG. 4. Female, aged forty-one. Severe cranial involvement of fibrous dysplasia. Appearance like that of leontiasis ossea. Note extensive densities and translucencies in frontal squama. Obliteration of frontal and ethmoidal sinuses and nasal cavity. Displacement of right orbit.

sella turcica. The roofs of the orbit, the wings of the sphenoid bones, and the anterior and posterior clinoids are characteristically transformed into sclerotic bone masses. Later, the sinuses and nasal cavity also become filled with dense bone. The slow but apparently relentless proliferation of newly formed osseous tissue may displace the entire orbit with its contents, usually downward and outward, and proptosis may develop. The malar bones may protrude and the entire facial skeleton become deformed. Such bone deformities are associated with marked changes in facial appearance, sometimes to the extent of fearful disfiguration: protrusion of the cheeks, displacement of the orbits, bulging

of the forehead, and an immobile, mask-like expression.

#### DISCUSSION

Classification of the cranial manifestations of fibrous dysplasia is somewhat more complicated than that of the skeletal changes. The present nomenclature includes several large groups of bone disorders which are probably identical to fibrous dysplasia. These have been described variously as "osteitis fibrosa cystica" or "fibrocystic disease" of the calvarium, certain forms of "hyperostosis cranii," "hemicranioses" (Brissaud et Lereboullet), "leontiasis ossea," "juvenile Paget's disease," "unilateral von Recklinghausen's disease of the skull," and so forth. It would be futile to try to identify with accuracy all old cases and names of this disease which appear in literature. Most reports contain no biochemical records of skeletal surveys, which would have provided the chief distinguishing features. Only occasionally are the older roentgenographical and pathological descriptions and illustrations helpful.

In the "prehistoric" references at my disposal, the earliest description of a skull affected by fibrous dysplasia, recorded as leontiasis ossea, is cited by Bardenheuer and Lossen. This case went into literature as one of the earliest observations of leontiasis ossea. The skull revealed enormous thickening of the vault and bones of the face. Large holes containing heavy spicules and irregular, wart-like, bony deposits were present in the thickened bones which were brittle but very hard. In von Recklinghausen's original description, his Case 5, a woman, aged sixty-six, with hyperostosis of the skeleton revealing a cyst in the occipital squama, is listed by Albright as a case of fibrous dysplasia. After a thorough study of the report of this case, I likewise am of the opinion that it is identical with fibrous dysplasia of the vault, because the bony walls of the cystic deformity were formed of compact, dense, hard, bony tissue. (In hyperparathyroidism, von Recklinghausen,

the bones are so soft they can be cut with a knife.) The celebrated specimen of the Musée Dupuytren is probably another case of fibrous dysplasia, revealing large bony cysts of the vault associated with increased thickness and density of cranial bones. (For figure, see Cushing and Eisenhardt's monograph.)

In later years, Schüller collected many records of the known cases of "cranial hyperostosis." According to his description, certain cases of this disorder, and also of osteitis fibrosa cystica of the skull, hemi-craniosis (Brissaud et Lereboullet), and hemihypertrophy of the skull and face associated with unilateral skeletal disease, must now be considered as fibrous dysplasia.

A wealth of information is contained in an article by Reiss who described all published cases of leontiasis ossea to 1935. In my estimation more than one-third of these cases conform to cranial localization of fibrous dysplasia. Mostly, they are characterized by their onset in childhood and the presence of homologous unilateral cranial and skeletal deformities. Kienböck, who attempted a critical evaluation of the old references concerning leontiasis ossea, collected quite a number of cases which he called "von Recklinghausen's type" of leontiasis ossea. Cysts were present in the bones of the skull and face, but no biochemical changes typical of hyperparathyroidism were discovered. Many of these old cases likewise must be classified with the fibrous dysplasia group. More recent case reports and references appear in articles by Furst and Shapiro, Lichtenstein and Jaffe, Sternberg and Joseph and others.

#### CLINICAL ASPECTS

Fibrous dysplasia of bone is primarily a disease of childhood, but because of its protracted course, the condition is not encountered medically until adolescence or adult life. It is more frequent in females. Onset is insidious, progress slow, and the deformity becomes manifest only at the height of the disease unless early signs are

discovered accidentally by roentgen examination.

General clinical symptoms and biochemical and roentgenological findings in the skeleton have been frequently described, emphasis being placed on the characteristic bone changes with their resultant cranial and skeletal deformities. Endocrine disturbances, precocious puberty in females, occasionally hyperthyroidism, and cutaneous pigmentation are present in about one-third of the cases. Recently, concomitant cardiovascular and renal disorders have been reported. The clinical entity is also known as Albright's syndrome.

Concerning cranial involvement, clinical changes consist of focal symptoms resulting from occasional local cortical irritation and displacement of adjacent structures. In advanced cases, narrowing of the cranial cavity and of the nerve canals is often associated with clinical symptoms. Generalized endocranial pressure causes increase of headaches, mental deterioration, and impairment of vision and smell. Obliteration of openings of paranasal sinuses, tear ducts, and nose often causes inflammatory changes and upper respiratory infections. Edentulous jaws are common in such condition. Progress of the disease in the skull seems to stop with the termination of normal bone growth or with puberty. It is reasonable to believe that the common clinical history of sinus disease prior to the beginning of facial deformities may be the result and not the cause of early bone changes, as it was often believed. Biochemically, in contrast to von Recklinghausen's disease, the calcium and inorganic phosphorus content of the blood is average. Occasionally, phosphatase is slightly increased. In severe cases, serum and urine calcium may be somewhat elevated.

#### HISTOPATHOLOGY

The primary histopathological change seems to be the transformation of rather extensive areas of bone marrow into connective tissue, following severe bone destruction by osteoclastic activity and lacunar



FIG. 5. Photomicrograph ( $\times 20$ ) of transverse section of thickened, deformed calvarium (same case as Fig. 2, B and C). Thin, cortical area at top is formed by lamellated normal structured bone of periosteal origin. Cortical bone layer (center) extends into diploë where it fuses with new-formed metaplastic, poorly calcified non-lamellated bone spicules imbedded in fibrous tissue. Two large holes below cortical layer are filled with connective tissue, revealing retrogressive changes. The lower part of the section shows dense bony islands consisting of meshwork of newly formed, metaplastic, non-lamellated bone surrounded by connective tissue.

cal skull findings are described by Trauner ("hyperostosis"), Lichtenstein and Jaffe, and others.

#### MICROSCOPICAL STRUCTURES OF ROENTGENOGRAPHIC TRANSLUCENCIES

Radiolucent areas visualized in fibrous dysplasia are the result of replacement of lamellar bone by connective, osteoid and non-lamellar bone tissues. The tela ossea is gradually destroyed from the fibrous marrow. The connective tissue tends to proliferate, and by lacunar erosion and osteoclastic activity the adjacent bone lamellae becomes resorbed. At the same time, due to periosteal activity, new lamellar bone tissue is formed on the outer surfaces of the focus through which the bony outlines become elevated, and a "cyst" is formed. Various amounts of primary, irregular, uncalcified, or poorly calcified trabeculae become visible within the connective tissue. They form an irregularly woven felt-work which supports the outer and inner tables. The connective matrix consists of numerous spindle-shaped, regu-



FIG. 6. Photomicrograph ( $\times 250$ ) showing group of xanthoma cells surrounding blood vessels. Cells large, cytoplasm translucent, nuclei small and localized peripherally. No fat stains available to determine probable fat content. Note many interstices and few nuclei in connective tissue. Xanthoma cells originate from adventitial cells of blood vessels, contain products of retrogression of previous tissue structures (fat from bone marrow?).

resorption. Connective structures may exhibit signs of growth. In this connective tissue primitive non-lamellar or woven bone is formed, which may either remain uncalcified, or be transformed into calcified irregular lamellar bone. Telford first described the presence of hyalin cartilage in skeletal "osteitis fibrosa" (fibrous dysplasia). Sternberg and Joseph found no cartilage in skull changes. Histopathologi-

larly stained cells and intercellular fibers distributed in bundles, rows, and sometimes in whorls. They may undergo different metamorphoses. The collagenous interstices may increase in number, whereas the number of cells may decrease. Occasionally, microscopical structures result, not unlike fibroma, with prevailing connective collagenous interstices and very few cells; or varying degrees of retrogressive change

as the newly formed metaplastic primary bone lamellae.

#### MICROSCOPICAL STRUCTURE OF RADIOPAQUE AREAS

The radiopaque areas are consistent with newly formed and in early stages inadequately calcified osseous tissue. This seems to be formed, not by osteoblastic activity, but by metaplasia of already existing con-

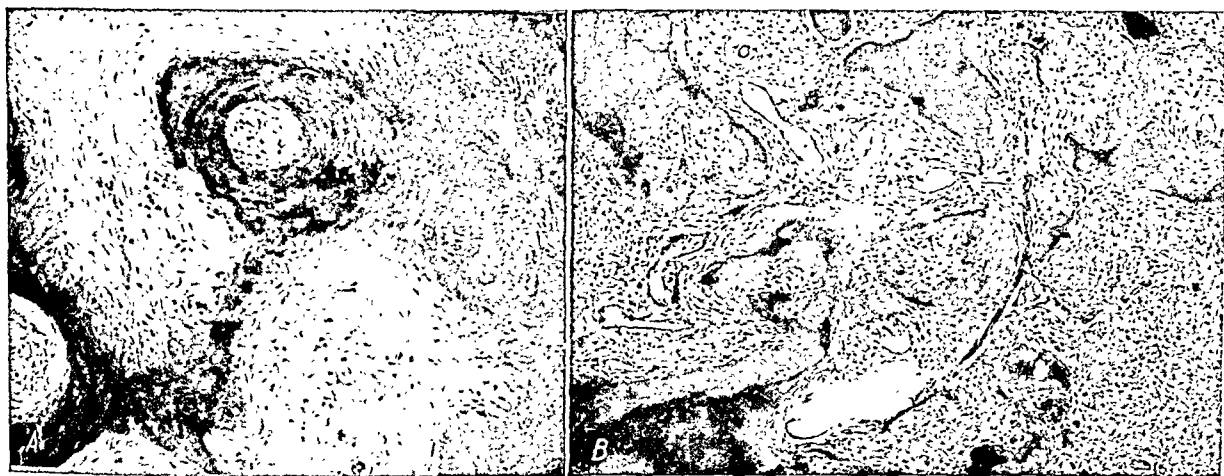


FIG. 7. *A*, photomicrograph ( $\times 250$ ) shows metaplastic bone formation in connective tissue replacing marrow. Brushlike outlines of bone trabeculae indicate homogenization of connective fibers and their fusion into osteoid tissue. Transformation of connective tissue cells into bone cells is shown in the margin of bone trabeculae on the right.

*B*, photomicrograph ( $\times 250$ ) reveals different phases of bone formation within osteoid tissue. Wide "pink" areas outside bone lamellae show osteoid tissue. In center of "pink" areas, more bluish stained, sharply outlined meshwork of well calcified, irregular lamellated bone tissue, showing erosion from within. Connective tissue reveals numerous capillary blood vessels.

may occur. Cell nuclei and fibers may disappear and a meshwork of cystic holes of different sizes and shapes may replace the connective structures. These spaces are filled with faintly eosinophilic, granular material. Occasionally, small groups of xanthoma cells are visible in the vicinity of blood vessels, indicating resorption of fatty material from the tissue of the dysplastic focus. Snapper and Parisel believed that the presence of xanthoma cells indicated that the whole pathology might be a secondary modification of xanthomatous change. This theory has since been disproved by several authors.

Bone destruction within the translucent areas involves the old, normal bone as well

nective tissue. Homogeneous substance is deposited between the connective fibers, and gradually the connective tissue cells become enclosed in cell spaces to form the bone cells. Later, calcium salts are deposited in the newly formed matrix. The primitive bone, when first formed, shows ill defined, brush-like margins. Many sections remain uncalcified; some of them are gradually replaced by lamellar bone. The transition from normal bone into primary pathological structures is not sudden. Organized bone lamellae are surrounded by osteoid structures which are embedded in a connective matrix. Findings are similar to those which occur in inflammatory conditions where woven bone is formed on the



FIG. 8. Photomicrograph ( $\times 150$ ). Oblique section of blood vessel surrounded by well calcified sheath of non-lamellated bone. Note connective tissue replacing bone marrow.

surface of lamellar bone. This indicates that the surface of lamellar bone has undergone some osteoclastic erosion. It is remarkable that newly formed bone trabeculae as well as osteoid tissue are often localized in surroundings of blood vessels. Lamellar bone structures ("blue" in hematoxylin-eosin stains) are narrower and smaller than the woven, non-lamellar structures ("red" in same stains). Some of them run parallel to the surface and serve to reinforce the structure of the vault. Occasionally, at the edge

of the lesion, a single trabecula may form the demarcation between normal marrow and dense, fibrous tissue. Ossification is more extensive where the mechanical stress is greatest, such as at the base of the skull.

The fate of this newly formed bone tissue is various. Some lamellae may again be destroyed by lacunar resorption and osteoclastic activity; others seem to remain as a more or less permanent part of the tissue structure.

Periosteal bone formation occurs in the vicinity of expanded foci of dysplasia, furnishing the bone shells around connective tissue. The original periosteal bone is also decomposed and again regenerated, and the process is repeated as long as small residues of the periosteal bone are present.

#### ROENTGEN DIAGNOSTIC ASPECTS

The roentgenological diagnosis of fibrous dysplasia of the skull is based on the morphology of bone changes. It seems that the distribution, extent and appearance of the newly formed bone tissue follow specific rules. These are influenced by the vascularization of connective tissue and by the statics of the cranium which differ from those in other parts of the skeleton. The base of the skull, which is subjected to

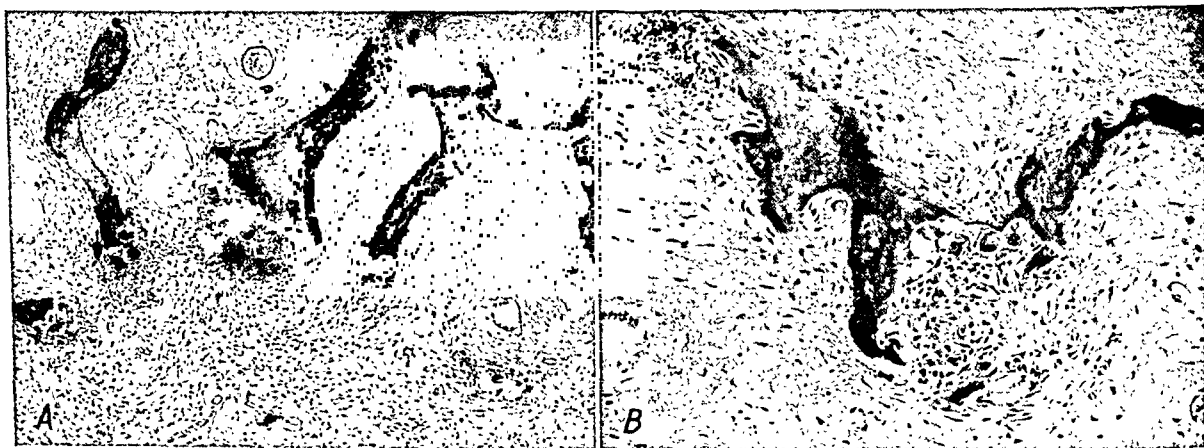


FIG. 9 *A*, photomicrograph ( $\times 150$ ). Irregularly distributed, poorly calcified non-lamellated bone revealing destruction in semicircular area at border of larger masses of connective tissue. Area of bone destruction shows marked hyperemia; red blood corpuscles outside wall of capillary blood vessels. At left, note several osteoclasts in Howship's lacunae at margin of destructive processes.

*B*, photomicrograph ( $\times 250$ ). Irregular, small, newly formed and poorly calcified metaplastic bone spicule shows an area of destruction with numerous osteoclasts and highly vascularized connective tissue.

greater stress than the calvarium, produces more bone tissue. Consequently, it is dense in roentgenograms. Later, however, this tissue grows not only according to its adaptation to static principles, but also as a result of intrinsic factors of osteogenesis. Bone formation, often following the course of the greater blood vessels and their well defined borders, produces sharply outlined densities. In roentgenograms, these alternate with translucent areas of connective or non-calcified osteoid tissues. The presence of dense bone spicules and alternating clear, translucent areas of ground glass quality are characteristic roentgenographic findings. Visualization of them permits not only the correct diagnosis to be made but differential diagnostic considerations of cranial manifestations of roentgenologically similar systemic bone diseases as well.

In von Recklinghausen's disease, cystic changes in the skull are associated with characteristic, diffuse, granular decalcification of the entire cranium. Consequently, if the general background remains normal in appearance, the cystic changes cannot be considered von Recklinghausen's disease. In xanthomatosis, Schüller-Christian's disease, and other reticulo-endothelial disorders, no true cysts are observed. Defects of the vault do not possess their own bony wall; they are simple, large, sharply outlined, and often multiple holes. In both von Recklinghausen's and Schüller-Christian's diseases, the clinical picture is entirely different from that of fibrous dysplasia.

Solitary xanthomas and other bone defects of the skull do not produce appreciable amounts of bone; consequently, as a rule, they do not reveal internal bone structures.

In Paget's disease, the margins between normal and transformed bone are mostly not sharply outlined; transition is continuous. The cotton wool appearance of the bones of the skull in Paget's disease usually reveals rounded, indistinctly outlined densities. They are surrounded by coarse, trabeculated residuals of spongy structures of the diploe. Larger, ground glass-like translucencies are absent. In addition, the

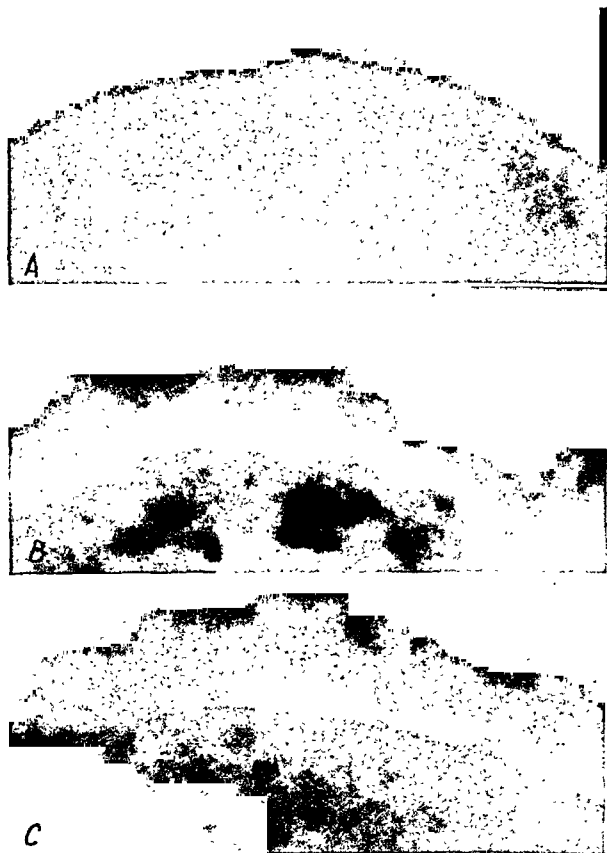


FIG. 10. *A*, roentgenogram of vault in hyperparathyroidism ( $\times 2$ ). Note thickening of diploe. Inner and outer tables have almost entirely disappeared; diploic structure replaced by decalcified coarsely granulated bone tissue surrounded by faint, almost point-like meshwork of more translucent areas. No large islands of newly formed bone tissue; no cystic changes.

*B*, part of cranial vault in fibrous dysplasia. Densities more sharply outlined, no "cotton-wool appearance", but irregular masses and spicules of extremely dense bone tissue. In contrast to Paget's disease, large holes appear which do not contain spongy structures. Inner table much denser. Outer table has disappeared and structural changes mainly involve area of diploe.

*C*, part of cranial vault in Paget's disease ( $\times 2$ ) revealing thickening of bones with fuzzy outlines. Rounded densities surrounded by translucent areas which contain coarsely trabeculated spongy structures. No hole formation evident in Paget's disease. Inner table very thin. Outer table has disappeared entirely, and structural changes involve regularly expanded diploe.

disease produces a relatively uniform thickening and, in advanced cases, characteristic enlargement of the cranial vault. This seems to be the result of softening of the newly formed Paget bone. It involves large



areas of the cranium. Usually, there is no circumscribed bulging or expansion of the bones. If the entire cranial vault is involved by Paget's disease, the roentgenological changes are so characteristic that they cannot be confused with the irregular, sharply outlined spicules, densities, and cyst-like translucencies of fibrous dysplasia.

It is important to distinguish the foci

#### RELATION OF FIBROUS DYSPLASIA TO LEONTIASIS OSSEA

According to the present extent of our knowledge, we must distinguish three types of leontiasis ossea, namely, Virchow's type, Paget's type and von Recklinghausen's type. The frequent incidence of fibrous dysplasia of the skull prompted me together with W. Cutting to review this problem.



FIG. 11. *A*, "leontiasis ossea" due to Paget's disease. Forty-five year old woman with extensive skeletal involvement. Note thickening of anterior wall of maxillary sinus, alveolar process, and base of skull. Paget structure of frontal squama.

*B*, "leontiasis ossea" due to Paget's disease of the mandible and calvarium. Sixty-four year old nurse with skeletal Paget's disease. Mandible almost twice as large as normal.

of fibrous dysplasia from bony reactions occurring around meningiomas. In moderate or severe cranial involvement, the deformity of the skull is so characteristic that it cannot be confused with circumscribed hyperostosis occurring in meningioma. Bony reactions of meningiomas are progressively growing, solid thickenings of the vault. Destructive bone lesions caused in rare instances by meningiomas are, in contrast to foci of fibrous dysplasia, not surrounded with continuous bone margins. Fibrous dysplasia starts in early youth. Bony reactions of meningiomas occur, as a rule, in adults. They involve first the inner table; diploe and outer table are changed later. In fibrous dysplasia the diploe is the primary localization of the disease.

Our studies convinced us that the majority of cases described as Virchow's, and especially as von Recklinghausen's type of leontiasis ossea, which showed no signs of diffuse osteoporosis and no biochemical abnormalities, were synonymous with fibrous dysplasia. Roentgenograms appearing in such communications can sometimes be identified as typical pictures of fibrous dysplasia. In a recent publication, we segregated cases of leontiasis ossea caused by fibrous dysplasia and classified them as "fibrodysplastic type" of leontiasis ossea. In the current literature, cases of Freedman, Gemmel, Case 1 of Hodges, the case of Kirkland, Case 3 of Kienböck, all described as leontiasis ossea, seem to be identical with fibrous dysplasia of the skull.

In a recent publication, Pugh also emphasized the close relation of fibrous dysplasia of the skull to leontiasis ossea. He thought that this relationship might be the explanation of leontiasis ossea. I have already pointed out that according to available information, fibrous dysplasia is the most frequent but not the only cause of leontiasis ossea. Second in frequency is Paget's disease of the bones of the face. The

not unlike small inflammatory changes or tumor metastases. Usually, these small cysts are located in the occipital squama, but occasionally appear in the parietal and frontal. Biopsy findings of two of such small, sharply outlined, rounded translucencies with relatively dense borderlines and of a third case representing a larger, oval, blister-like cystic translucency above the orbit, revealed that they consisted of holes

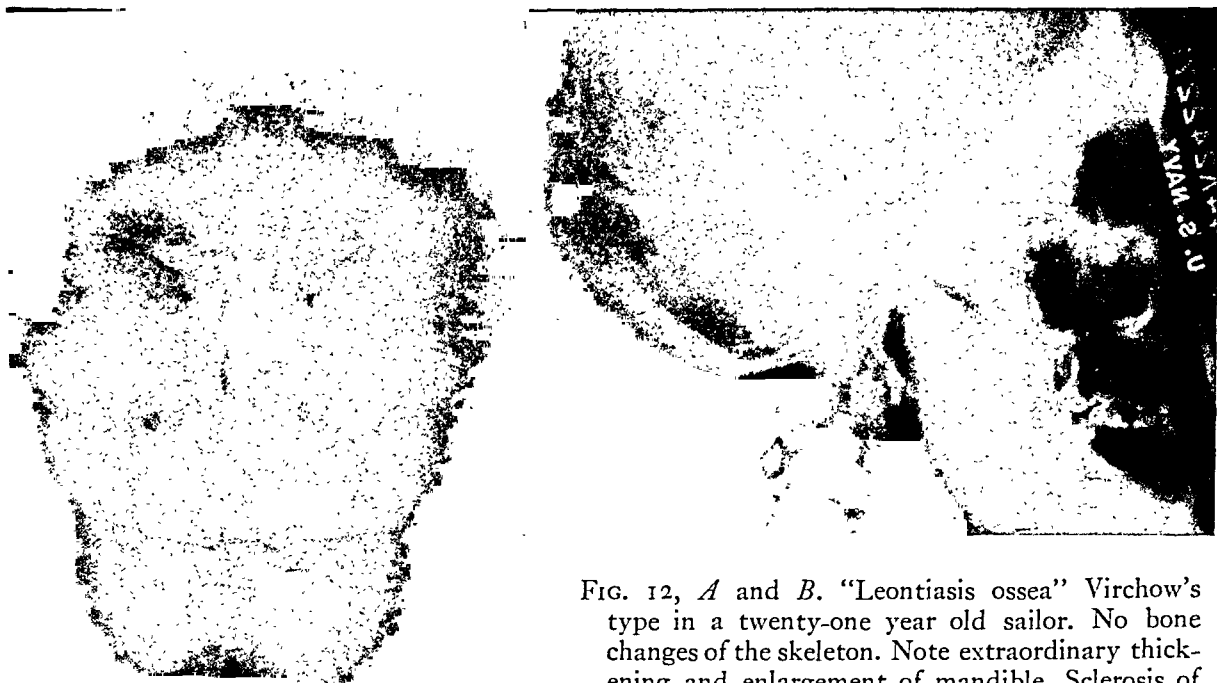


FIG. 12, *A* and *B*. "Leontiasis ossea" Virchow's type in a twenty-one year old sailor. No bone changes of the skeleton. Note extraordinary thickening and enlargement of mandible. Sclerosis of base of the skull (anterior and lateral views). (Courtesy of Dr. E. Leef.)

original Virchow's type seems to be one of the rarest of all conditions leading to leontiasis ossea. Unexplained remain also cases of massive diffuse bony deposits on the facial skeleton showing roentgenographic density of marble bones. Such cases are occasionally associated with skeletal changes similar to melorheostosis (Franklin and Matheson).

#### RELATION TO SIMPLE BONE CYSTS OF THE CRANIAL VAULT

Circumscribed small translucencies of the cranial vault are a relatively frequent roentgenographic finding. As previously mentioned, small foci of fibrous dysplasia may produce circumscribed translucencies

within the diploe. They were outlined by shiny connective membrane. In all 3 cases, the meninges and portions of the cerebral cortex had prolapsed into the holes. In one case, the cyst wall itself was formed of dense bone layers with hardly any fibrous change in the small marrow cavities. The bone layers were irregular in build. In one case, irregular structures of partly non-lamellated bone were observed; ossified bone spicules ended abruptly at the level of the connective membrane outlining the border of the hole. In the third case (cyst above the orbit), no bone particles were examined; however, the cyst contained, in addition to brain tissue, small amounts of spindle-shaped connective tissue cells with

collagenous interstices in whorls and bundles.

The histogenesis of these holes is difficult to interpret. It is possible that the holes represent degenerated and resorbed areas of fibrous dysplasia, in which the inner table has become entirely atrophic and the meninges and parts of the cortex prolapsed into the space previously occupied by connective structures of fibrous dysplasia. (See also case of Neller.) In only one of our

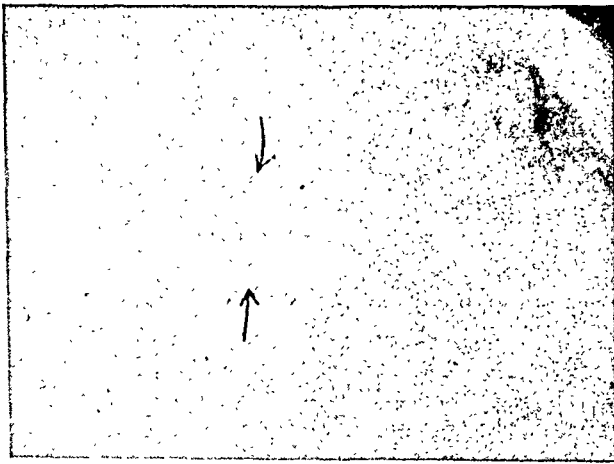


FIG. 13. Male, aged sixty-eight. Triangular bone defect in left parietal bone surrounded by slightly denser bone structures. No change in appearance during two years' observation.

cases was such a metamorphosis likely. This showed abruptly ending and somewhat irregular and partly incompletely ossified non-lamellated bone structures with some fibrous changes in the bone marrow. Other possibilities in explanation of the origin of these cysts, namely tissue malformation, degenerated fibromas, xanthomas, and so forth, cannot be excluded.

#### COMMENTS AND SUMMARY

It has been pointed out that fibrous dysplasia of bone frequently involves the skull. The extent of cranial manifestations is related to the extent of the involvement of other parts of the skeleton. Roughly, in 10 cases of monostotic skeletal involvement, one cranial case has been recorded. In moderate skeletal involvement, about half the

cases show skull changes. In severe skeletal disease, the skull participates constantly. Occasionally, the skull shows the only manifestations of the disease, whereas no skeletal changes and no clinical findings of related endocrine disturbances are encountered.

Pathological and roentgenological evidence of foci of the disease are in limited cranial manifestations—small, simple, cyst-like bone blisters in the vault. In more advanced cases, localized deformities with translucencies and densities within the deformed areas are observed. In later stages, extensive, dense, bony islands and spicules become visible in the expanded parts. In severe involvement, the entire vault, the base of the skull, and the facial skeleton are deformed. Bone deposits are maximal and localized mainly at the base of the skull and in the face.

Prior to the segregation of fibrous dysplasia from related conditions, misinterpretations were frequent. They were classified and denominated as cranial hyperostosis or, if localization was unilateral, as hemicraniosis, hemihypertrophy, unilateral hyperostosis, unilateral von Recklinghausen's disease, osteitis fibrosa cystica of the skull, or von Recklinghausen's disease, and so forth. Most of the advanced cases, however, have been reported as leontiasis ossea. There are indications that skull specimens known as leontiasis ossea since the last century were actually fibrous dysplasia.

The basic tissue change is replacement of the diploe by connective structures (visualized roentgenographically as translucencies) in which irregular, poorly or completely ossified, non-lamellated bone tissue may develop (visualized as densities). In advanced cases, these densities are in the foreground and the bone changes may show diffuse areas of increased density. This is especially characteristic at the base of the skull. Detailed roentgenological analysis of the appearance of the fibrous dysplasia usually permits recognition and denomi-

nation of this condition and its differentiation from von Recklinghausen's disease, Paget's disease, and xanthomatosis. Segregation of skull changes from localized bone reactions caused by meningioma is of great practical importance.

Localized clinical symptoms caused by fibrous dysplasia of the skull are present in cases of severe involvement. General symptoms are identical with those of Albright's syndrome. A skeletal and clinical survey of each case presenting cranial manifestations of this disorder is an urgent necessity.

I am indebted to Drs. Alvin C. Cox and H. W. Carnes of the Department of Pathology, Stanford University School of Medicine, for placing microscopical slides at my disposal. I am also indebted to Dr. Edward Leef of the Department of Radiology for Figures 2A and 12.

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# PULMONARY EMPHYSEMA AND TUBERCULOSIS\*

## A ROENTGENOLOGICAL AND PATHOLOGICAL STUDY

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**P**ULMONARY emphysema as a sequel and complication plays an important part in the course of all forms of pulmonary tuberculosis. Every physician who comes in contact with tuberculous patients knows how frequently bronchitis, asthma, and emphysema are diagnosed as the primary disease in patients who have had pulmonary tuberculosis for many years. In such cases signs and symptoms of non-tuberculous pulmonary disease must be

lung tissue, and especially by endobronchial changes.

The purpose of this study was to investigate the various forms of emphysema in pulmonary tuberculosis and to classify them on the basis of morphology and pathogenesis. It is felt that the term "compensatory emphysema" should be limited to those cases which do not show definite bronchial changes.

### MORPHOLOGY OF EMPHYSEMA IN TUBERCULOUS LUNGS

In discussing the various pathological features of emphysema in tuberculosis, it is necessary to differentiate between (1) the individual tuberculous lesion, and (2) the stage or phase of tuberculous disease.

In the majority of cases of pulmonary tuberculosis, the emphysematous changes are not diffuse, but are localized in the area and in the immediate vicinity of the tuberculous lesions. These changes may be classified

- (a) Intrafocal emphysema
- (b) Perifocal emphysema
- (c) Emphysematous bullae and blebs
- (d) Interstitial emphysema
- (e) Diffuse (compensatory) emphysema

(a) In *intrafocal emphysema* there is no doubt that bronchial and bronchiolar obstruction play the most important part. Exudate and liquefying necrotic material are present in the bronchial tree, and air is trapped within the soft lesions due to a check valve mechanism. In the pathogenesis of fresh cavities this mechanical factor is not only of great importance in determining their size, but it may influence spontaneous healing or lead to rapidly progressing tuberculosis.

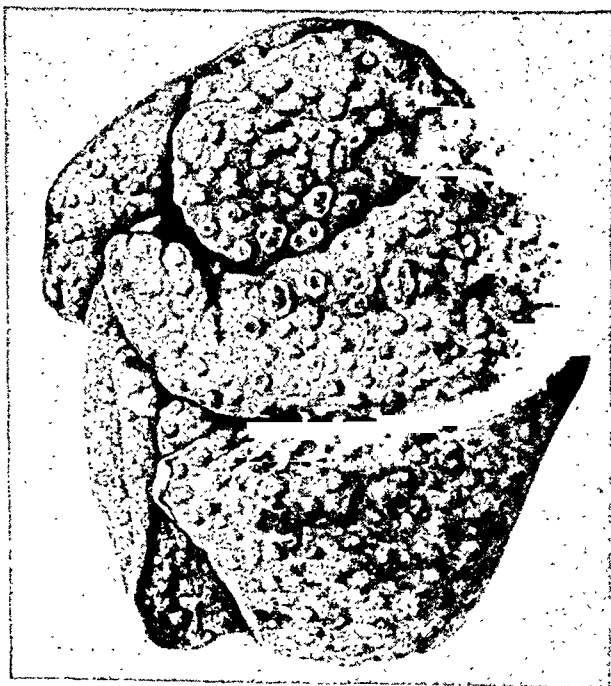


FIG. 1. Lung specimen of progressive miliary tuberculosis. Intrafocal emphysematous blebs (from Pagel<sup>7</sup>).

considered as phenomena secondary to tuberculous lesions in the lungs. Emphysema associated with pulmonary tuberculosis is as manifold pathologically as in other chronic pulmonary diseases which are characterized by fibrosis, destruction of

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Small intrafocal air bubbles are limited to cases of an exudative character; in areas of perifocal inflammation, and occasionally in soft miliary tubercles in which caseation is predominant (Fig. 1). Intrafocal emphysema is not limited to tuberculosis, but is frequently found in pulmonary edema, and in bronchopneumonia. In tuberculosis it is not of great clinical significance, because it seems that in the majority of these cases the trapped air is readily absorbed or expelled, depending on the complete occlusion or complete re-opening of the bronchus.

(b) *Perifocal emphysema* is by far the most common type. Emphysematous changes are almost always present, in the immediate vicinity of fibrotic and productive lesions, and to a much lesser degree around exudative lesions (Fig. 2 and 3). In the periphery of calcific foci it is never absent, unless the calcium is deposited in solid fibrous tissue. The amount of emphysema does not parallel the size of the lesion.



FIG. 2. Perifocal emphysema with blebs in caseous pneumonic tuberculosis.



FIG. 3. Fibro-exudative and cavernous lesions. Extensive perifocal emphysema.

Frequently little or no emphysema is found near large fibrocalcific areas, while tiny calcific foci may be suspended in an extensive emphysematous region (Fig. 4).

Such discrepancies cannot be explained on the basis of a shrinkage of the original lesion alone, although we agree that a prolonged pulling on neighboring relatively normal lung tissue might lead to dilatation of alveoli and to stretching and rupture of their septa. Much more significant in the pathogenesis of perifocal emphysema is the condition of the smaller bronchi and of the bronchioli within and in the periphery of lesions while they are undergoing progressive or regressive changes. In chronic



FIG. 4. Multiple calcifications with extensive emphysema.

atelectatic and fibrotic lung tissue three characteristic changes may be found: ectasia of larger bronchi leading to the lesion, so-called alveolar hyperplasia within the fibrotic areas, and obliteration as well



FIG. 5. Bilateral emphysematous blebs in case of fibrotic apical lesions.

as disappearance of bronchioles in the entire region. It may be assumed that the bronchiolar changes come first, and that in the case of fibrosis and atelectasis their obstruction is complete and permanent. In the case of emphysema, however, the bronchi and bronchioles are never completely blocked. Their partial obstruction as outlined under (a) intrafocal emphysema may lead to overdistention of alveolar structures.

Perifocal emphysema varies in appearance from small areas of minimal disten-



FIG. 6. Emphysematous blebs with septa formed by thickened pleura.

tion of alveoli to large bulla-like structures, the interior of which is traversed by thin remnants of alveolar septa and obliterated capillaries.

(c) *Emphysematous bullae and blebs* have received major attention in the literature, probably not only because of their spectacular roentgenological and pathological features, but also because of their clinical

significance. On roentgen examination they must be differentiated from tuberculous cavities, pneumothorax, and cysts (Fig. 5 and 6).

A bleb is formed when the lung is separated from the pleura by interstitial emphysema, the greater part of its wall consisting of attenuated visceral pleura. In bullae the pleura retains its connection with lung parenchyma, and the pleura does not take part in the formation of the bullous wall. Both bullae and blebs remain unchanged over long periods of time, or they show only insignificant changes in size and shape.

It is a generally accepted theory that no bronchi are in communication with the lumen of these structures as soon as their wall has been definitely formed. It must be assumed, however—as in other forms of emphysema—that atelectasis would develop at the site of the original emphysema, due to an absorption of the trapped air, if the regional bronchi were entirely blocked. Since this does not happen in the majority of cases, it is felt that small narrowed bronchi still penetrate the walls of bullae and blebs, allowing air to enter, but preventing it from leaving during expiration. Manometric pressure readings of large blebs in a postmortem lung still showed high positive pressures (plus 8 and plus 11 cm. of water). The bronchographic findings therefore are not conclusive; the contrast fluid probably does not enter the blebs or bullae through the narrowed bronchioles.

Emphysematous bullae and blebs are a common sight in tuberculous lungs, especially in those with fibrotic changes. While generally blebs do not show necrotic changes of their walls, aspiration of tuberculous material into their interior is possible (Fig. 7, A, B and C).

(d) *Interstitial emphysema* is not found very often in tuberculous lungs, except as a complication in artificial and spontaneous pneumothorax. Air is pressed into the interstitial tissue, and is found especially along the vascular structures in the interlobular septa. This form of emphysema

may develop in cases of asphyxia, in whooping cough, and in severe cases of tracheobronchitis with pseudomembranes. The pearl-string arrangement of tiny emphysematous blebs in children is the classical example of interstitial emphysema.

(e) The term "*compensatory emphysema*" should be reserved for those cases in which relatively normal portions of lung tissue become hypertrophic, as the result of extensive fibrosis, necrosis, and atelectasis in other parts, with ensuing loss of respiratory surface. Compensatory emphysema always leads to pulmonary hypertrophy, but must be differentiated from senile emphysema in which the lungs are atrophic. It is relatively easy to make a differential diagnosis during autopsy. After opening of the pleural cavities, the hypertrophic emphysematous lung changes very little in size, while the senile atrophic lung collapses. Many cases of so-called compensatory emphysema, especially if limited to parts of a lobe, are not the result of compensation, but of extra- and endobronchial changes. The characteristic pathological and roentgen changes of these forms of emphysema will be discussed later.

#### EMPHYSEMA AND THE VARIOUS STAGES OF TUBERCULOSIS

(1) *Primary Tuberculosis*. It is very seldom that gross emphysematous changes are observed as part of an uncomplicated primary complex. The original lesion is of a pneumonic nature, and most of it undergoes resolution. As soon as the central caseous nucleus becomes calcified, perifocal emphysema may become manifest. There are cases in which the calcified Ghon focus is suspended in emphysematous lung tissue as in a spider web; this loose connection of calcified lesions with the surrounding tissue is probably the reason why in many cases such lesions are expectorated. Since the Ghon focus is most frequently located in subpleural areas, the residual emphysema is usually found in these regions. It can be assumed that many cases of spontaneous pneumothorax of so-called "non-tuberculous" origin are attributable to rupture of



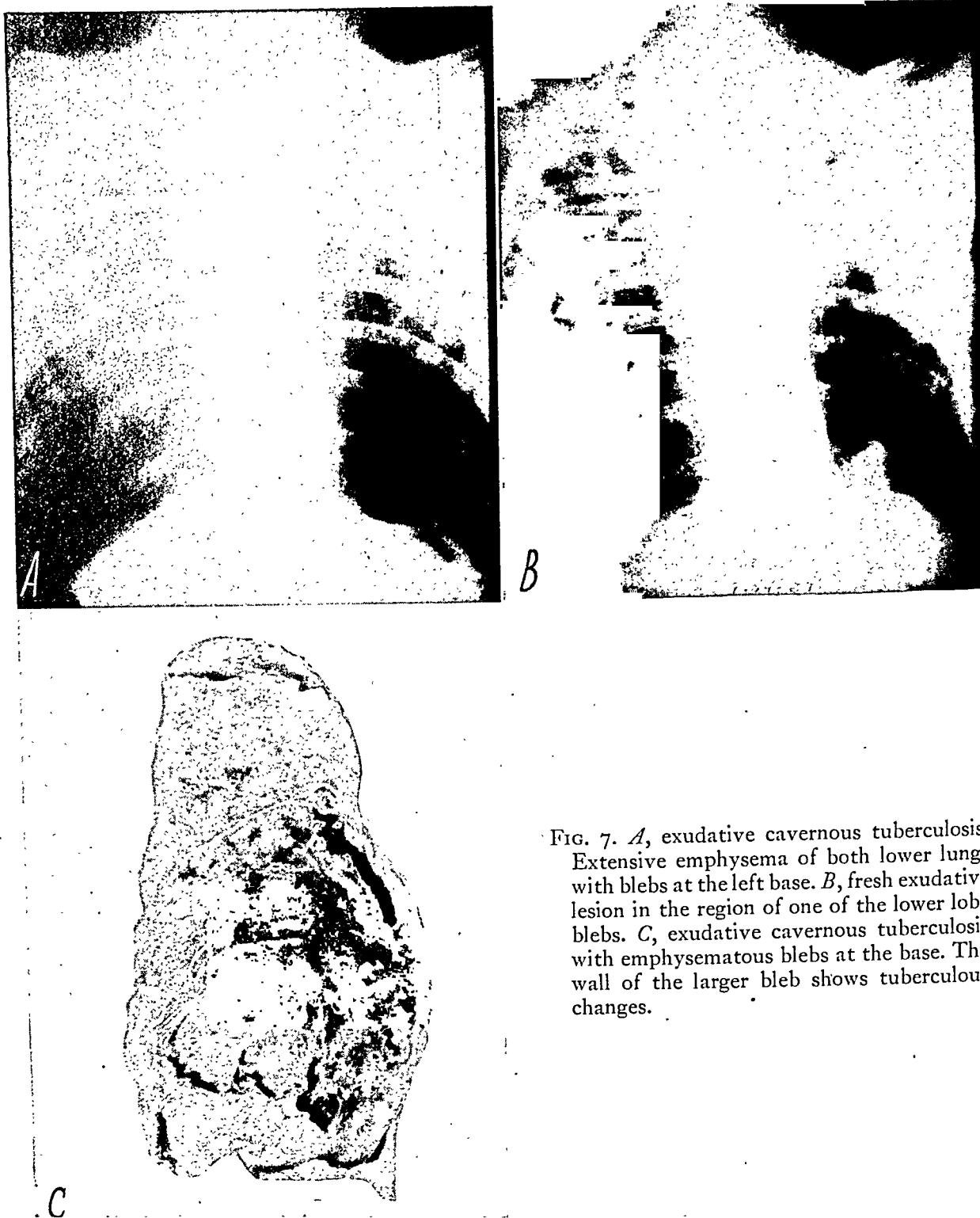


FIG. 7. *A*, exudative cavernous tuberculosis. Extensive emphysema of both lower lungs with blebs at the left base. *B*, fresh exudative lesion in the region of one of the lower lobe blebs. *C*, exudative cavernous tuberculosis with emphysematous blebs at the base. The wall of the larger bleb shows tuberculous changes.

such subpleural emphysematous lesions.

Obstructive emphysema may become part of an active progressive primary pulmonary tuberculosis if a caseated lymph node erodes through the wall of a bronchus, thus creating a valve-like mechanism. In many of these cases the emphysema is ac-

companied by a caseous pneumonic process. If the bronchus is completely occluded either by caseous material or by extrinsic pressure, an area of atelectasis may develop. So-called epituberculosis is probably identical with such atelectatic lesions.

(2) *Hematogenous Tuberculosis*. Emphy-

sematous changes as part of lymphohematogenous dissemination can be of various nature. In acute miliary tuberculosis, the tubercles may contain small air bubbles in their necrotic centers, giving the lung a spongy appearance. Pagel gives a beautiful illustration of such a rare case (Fig. 1), which is classified here as intrafocal emphysema.

tuberculosis" there is extensive disseminated fibrosis, and marked reduction in elastic tissue (Fig. 8, *A* and *B*).

Endobronchial tuberculosis cannot be ignored as a contributing factor in the development of emphysema as part of hematogenous pulmonary tuberculosis. In his classical description Pagel has demonstrated that such tuberculous endobron-



FIG. 8. *A*, fibrotic lesions in both lungs. Emphysema with bleb formation in lower thirds. *B*, emphysematous form of chronic hematogenous pulmonary tuberculosis. Numerous small blebs and bullae; extensive fibrosis.

An outstanding feature in many cases of chronic hematogenous pulmonary tuberculosis is the characteristic form of the complicating emphysema (Pagel<sup>7</sup>). It is a known fact that in such forms of pulmonary tuberculosis, the individual lesions are of a productive nature, and that dyspnea plays an important part in their symptomatology. If we accept the theory that in hematogenous tuberculosis the original pulmonary lesions are formed in the interstitial tissue, then there is no difficulty in explaining the symmetrical localization of the emphysematous areas. In such "emphysema-

chitis is frequently part of hematogenous tuberculosis.

In more acute cases of generalization in which the individual lesions are of a caseous pneumonic nature, there is a distinct tendency to calcification. Again the secondary emphysema becomes of pathological and clinical importance, much more so than in isolated pulmonary tuberculosis. It is in such cases that we find extensive circulatory disturbances, consisting of atheromatosis and sclerosis of pulmonary vessels, and acute and chronic dilatation of the right heart.

Emphysematous bullae and blebs are frequently found in widespread chronic hematogenous tuberculosis. Many of the apical blebs are caused by scar tissue which in turn resulted from abortive hematogenous spreads ("fibrosa densa," Simon foci).

(3) *Chronic Isolated Pulmonary Tuberculosis*. Emphysema in the early exudative stages of chronic pulmonary tuberculosis is of minor importance. Only as a contributing factor in the formation of rapidly developing cavities does emphysema gain in significance. These are probably intrafocal air collections, with round thin-walled cavities, which, if cut off from a constant air supply, may shrink rapidly and close spontaneously.

The more chronic the tuberculosis becomes, and the more fibrosis develops, the more significant becomes the complicating emphysema. It was mainly in cases in which there was an extensive loss of normal lung tissue that the expression "compensatory" emphysema was employed. One of the outstanding symptoms in the vast majority of

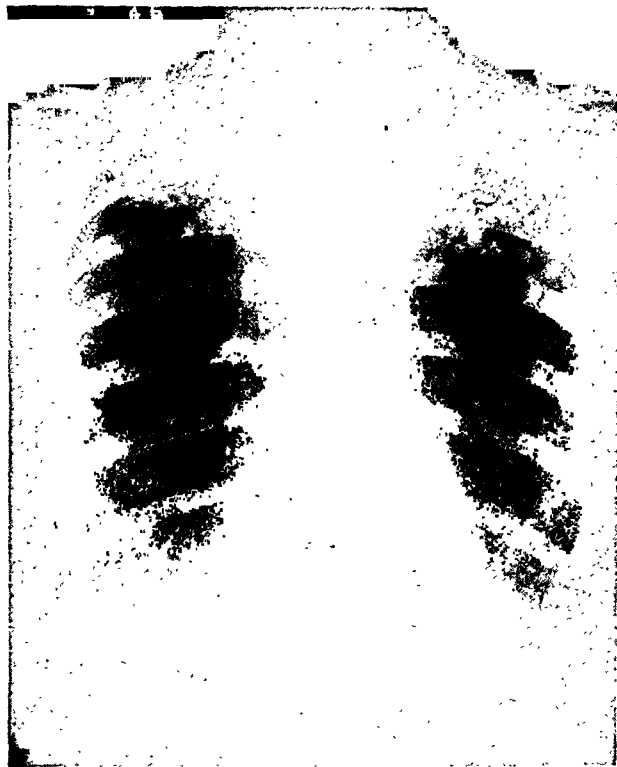


FIG. 10. Fibrosis of both upper lobes. Stretching of bronchovascular structures. Emphysema of lower portions of lung.



FIG. 9. Fibrosis of the left lung. Fibrocalcific lesions on the right with extensive emphysematous changes.

cases of chronic pulmonary tuberculosis is the copious sputum which occupies one or more parts of the bronchial tree at all times. We therefore believe that at least part of the emphysematous changes should be attributed to bronchial obstruction, and not merely to a purely compensatory mechanism. Even in cases in which both upper lobes are replaced by huge cavities, emphysema does not necessarily develop in the remaining normal lower lobes. Hypertrophic emphysema of a lobe or even of an entire lung does not develop very rapidly. It may take several years before the characteristic features of so-called compensatory emphysema become roentgenologically manifest: decreased lung markings, stretching of bronchial and vascular structures, widening of intercostal spaces, and a depression of the diaphragm (Fig. 9 and 10). The autopsy in such cases does not only reveal a distention of alveolar structure, but also an almost complete absence of bronchioli. On the other hand, an often considerable dilatation of larger bronchi can be found.

Although all forms of hypertrophic emphysema are to be found in chronic pulmonary tuberculosis, perifocal emphysema is most frequent. Bullae and blebs are features of clinically arrested lesions, and it is in such cases that spontaneous pneu-

show emphysematous changes. This emphysema is not always due to a purely compensatory process. There is frequently a displacement and torsion of mediastinal structures, and a partial fixation of the bony thorax. The resulting changes of the



A

B

FIG. 11. *A*, emphysema in fibrocalcific tuberculosis. Blebs in lower lobes. *B*, simultaneous spontaneous bilateral pneumothorax. The bleb in the right lower lobe did not collapse.

mothorax occurs most frequently (Fig. 11, *A* and *B*).

#### EMPHYSEMA AND COLLAPSE TREATMENT

The clinical and pathological significance of emphysematous changes during and after collapse treatment should not be overemphasized. It is a well known fact that after the artificial collapse of a diseased lung the pulmonary function not only does not decrease but that there is actually an improvement in the breathing capacity of many patients.

There can be no doubt, however, that during pneumothorax treatment as well as after thoracoplasty, hypertrophic emphysema does occur in many cases. After part of a lung has become fibrotic following thoracoplasty, the non-collapsed tissue may

bronchial tree contribute to the formation of hypertrophic emphysema.

During pneumothorax treatment similar changes may take place, and bleb-like bulgings in the collapsed lung can be observed in many cases (Fig. 12). Following re-expansion of the lung such emphysematous areas will frequently disappear. In pneumothorax an overextended lobe or part of it can practically always be explained on a bronchogenic basis. Massive collapse (atelectasis) which sometimes follows emphysema in a pneumothorax lung points in the direction of bronchial narrowing and subsequent occlusion of the lumen.

In all those cases in which the contralateral lung offers roentgenological and pathological evidence of emphysema it has been found that there is almost without excep-

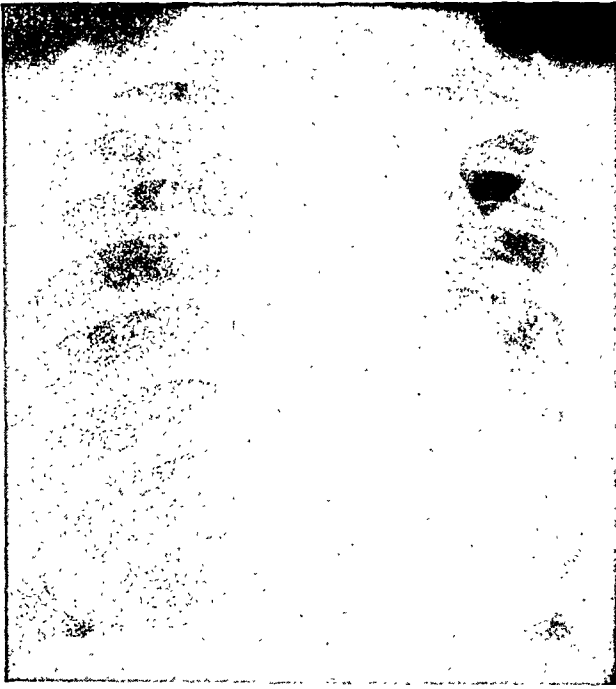


FIG. 12. Bilateral artificial pneumothorax, with bleb-like emphysema. Thickening of visceral pleura. Repeated spontaneous pneumothorax, right.

tion, a marked shrinkage of the collapsed lung with shifting of the mediastinum which is not pushed but pulled towards the shrunken lung. Even if the contralateral lung was free of tuberculous lesions, localized emphysema may develop on the basis of bronchial changes.

#### DISCUSSION

Up to the present time emphysematous changes in pulmonary tuberculosis have been considered part of a purely compensatory process, except for those cases in which bronchial obstruction could be clearly demonstrated. There is no doubt that in long standing tuberculous processes with considerable reduction of respiratory surface, the uninvolved parts of the lung will undergo certain changes which ultimately will lead to emphysema.

The pathogenesis of emphysema is still a subject of discussion now, as much as it was at the time when Laennec<sup>4</sup> first introduced the obstruction theory of pulmonary emphysema. Since then many theories have been promulgated, most of which had to be abandoned because of too little or no proof.

In discussing the pathogenesis of any form of pulmonary emphysema, it is neces-

sary to differentiate between hypertrophic and atrophic emphysema. The atrophic form which occurs as part of a general atrophy of the body will not be discussed in detail. Its clinical and pathological features are well known, but as far as its pathogenesis is concerned there is a marked difference of opinion. The theory of Trippier that in the early stages of emphysema the elastic fibres are hypertrophied is opposed especially by Tendeloo<sup>10</sup> who does not find definite changes in the elastic tissue which can be made responsible for early emphysematous changes. Letulle,<sup>5</sup> on the other hand, brings definite proof that in the later stages of emphysema the alveolar walls separate from the basal membranes, and that blood vessels and elastic fibers in the septa become atrophic. The original opinion of Virchow<sup>12</sup> that primary decrease of elasticity through atrophy leads to emphysema is opposed by Thannhäuser<sup>11</sup> who believes that loss of elasticity is the result and not the cause of the disease. That fixation and deformities of the bony structures of the thorax frequently lead to emphysema was already recognized by Freund<sup>2</sup> in 1859.

True atrophic emphysema is rarely seen in cases of pulmonary tuberculosis, probably because the vast majority of the cases belong in the lower age groups. For a long time the possibility of their simultaneous occurrence was very much disputed, but there is no doubt that in the aged atrophic emphysema and tuberculosis may coincide. The tuberculous lesions in such cases are usually of an exudative type.

Hypertrophic emphysema has been attributed to two major causes: bronchial obstruction, and hyperventilation of the lungs without obstructive changes. It has not been definitely proved that musicians, glassblowers, and high altitude workers develop true hypertrophic emphysema. The overventilation of the lung in such cases is of a temporary nature, and does not necessarily lead to permanent anatomical changes. Many cases of functional emphysema as described by Mayer and Rappaport<sup>6</sup> probably fall into this group. En-

largement of the lung, especially when of a temporary nature is not synonymous with hypertrophic emphysema.

It is well known that after thoracoplasty, lobectomy, and pneumonectomy the remaining parts of the lung become enlarged. It is not at all certain that such a hypertrophy must lead to hypertrophic emphysema. There is, however, the possibility that in such lungs atrophic changes will occur much earlier in life than usual. We may be able to use the well known experiments in dogs as proof of this fact. Within a year after pneumonectomy no clinical or pathological evidence of emphysema could be found (Rienhoff, Reichert and Heuer,<sup>9</sup> Bremer<sup>1</sup>); however, several years later emphysematous changes were detectable on autopsy (Paine).<sup>8</sup> We believe that pure compensation cannot be the sole cause of hypertrophic emphysema; in an otherwise normal lung the abundance of elastic and muscular tissue would not permit the permanent and progressive dilatation of alveoli, and to stretching and rupture of interalveolar septa.

There are two conditions which are almost always found in hypertrophic emphysema: (1) bronchial and bronchiolar obstruction, and (2) vascular changes in the lung.

(1) It is well known that under certain pathologic conditions acute dilatation of the lung can occur; however, in many cases such changes are reversible, and do not lead to hypertrophic emphysema. In acute respiratory infection such as whooping cough, diphtheria, and edema of the larynx, there is a temporary hypertrophy of the lung, but after the acute disease has passed, the lung shows a normal roentgen appearance. The changes have been caused by temporary bronchial obstruction. The classical example of acute emphysema due to bronchial obstruction is seen after drowning. Air and water are aspirated simultaneously and the lung may reach tremendous proportions (*volumen pulmonum auctum*). Only if the obstructing water can be removed from the air passages, can respiration be resumed.

Obstruction explains the development of emphysema not only in such acute diseases, but also in diseases of a chronic nature. The best example is chronic bronchial asthma, during the course of which the bronchial lumina are narrowed by spasm, swelling of the mucosa, and by exudate. It is therefore not surprising that emphysema develops in almost all patients with long standing asthma (Kountz and Alexander).<sup>3</sup>

In all forms of pulmonary tuberculosis, exudate in the bronchial tree occurs quite frequently, and it can be assumed that in the majority of cases localized emphysema is due to obstruction (localized drowning). In an attempt to analyze the role of bronchi and bronchioli we carefully investigated the bronchial tree in 10 cases of chronic pulmonary tuberculosis. In the vicinity of cavities and of exudative lesions we could always find one or more bronchi or bronchioli which showed tuberculous involvement of the mucosa, leading to narrowing or to occlusion of their lumina. After complete obliteration of the lumen, atelectasis will develop, because the air in the alveoli distal to the obliteration is absorbed and no fresh air can enter. We know now that such a mechanism is a prerequisite for the closure of cavities. However, the closure of cavities and the healing of exudative lesions by fibrosis produce pressure or torsion, involving the bronchial structures in the surrounding areas, leading to localized emphysematous changes. Microscopic emphysema to large blebs can be explained as the result of such a mechanism.

While the lung with senile atrophic emphysema collapses after the pleural cavity is opened, the hypertrophic emphysematous lung does not retract. This difference in behavior can be used as definite proof that air can escape from the intrapulmonary air passages in atrophic emphysema where bronchial obstruction is of little or no importance; the involved portions of the lung in hypertrophic emphysema do not collapse because of the valvular mechanism in the regional bronchioles.

(2) While in atrophic emphysema ather-

omatous and sclerotic changes in pulmonary vessels are of primary importance, in hypertrophic emphysema they are the result and not the cause of emphysema.

(a) In hypertrophic emphysema pathological changes are usually found in capillaries but not in larger vessels as in atrophic emphysema. Along respiratory bronchioles the capillaries are stretched, their lumina are narrowed and often obliterated. In many emphysematous areas no capillaries are found at all, a fact which explains the anemic appearance of emphysematous lung tissue. Although the histological proof is a difficult one, we assume that not only are the pulmonary vessels involved, but also the bronchial arteries and veins. The few capillaries which are found in emphysematous tissue are thin walled, dilated, and sometimes congested with blood.

The result of such vascular changes are nutritional disturbances of the lung parenchyma which in turn create additional degenerative processes (atrophy, necrosis, fibrosis).

(b) Emphysema is also found in congestion of pulmonary vessels as part of chronic heart disease. If the pulmonary circulation is impaired, the blood vessels are engorged, and exudate or transudate is found in the air spaces. In the extreme case of pulmonary edema, emphysema is part of the pathological findings.

(c) The behavior of the lymph vessels has been quoted in explaining healing processes in tuberculous lungs, especially as the result of collapse treatment. It is believed that congestion of lymph vessels stimulates fibrosis, and at the same time causes degeneration of elastic fibers. We know that elastic fibers are well preserved in caseous foci, while in fibrotic areas they are almost entirely absent. Although there is no direct proof, we believe that changes of the intrapulmonary lymph vessels play a part in the development of pulmonary emphysema.

#### SUMMARY AND CONCLUSIONS

1. An analysis of emphysema in pulmo-

nary tuberculosis leads to the conclusion that in only a small minority of the cases can the changes be explained on a purely compensatory basis.

2. Localized emphysema, whether intrafocal or perifocal, as well as bullae and blebs, is due to bronchial changes.

3. Obstruction of bronchi and bronchioles is caused by exudate, necrotic material, endobronchial tuberculous lesions, compression, torsion, and stretching.

4. In hypertrophic emphysema bronchial changes are of primary importance, while in atrophic emphysema vascular changes are of greater significance.

5. Emphysema occurs during all stages of pulmonary tuberculosis. It is of characteristic appearance in many cases of hematogenous tuberculosis.

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# LOEFFLER'S SYNDROME

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SCATTERED case reports of transitory lung infiltrations accompanied by eosinophilia have appeared in the literature from time to time under the designation of Loeffler's syndrome<sup>4</sup> and tropical eosinophilia.<sup>1</sup> The etiology of this condition is not definitely known, although some observers have felt it to be an allergic response of the pulmonary tissues to a wide variety of allergens. It has been found associated with pulmonary tuberculosis; infestation with *Ascaris lumbricoides*, *Necator americanus* and *Endamoeba histolytica*; pollen hypersensitivity; asthma; chronic brucellosis<sup>3,5</sup> and strongyloidiasis.<sup>2</sup> The benignity of the disease has prevented pathological observation. It has been postulated that in the course of certain infestations characterized by larvae, migrating through the lung tissues, the pulmonary changes may be due to hemorrhage from mechanical rupture of the alveolar walls or a cellular reaction to which infection may or may not be added.<sup>2</sup>

The symptoms are generally mild, usually consisting of cough with or without chest pain, and moderate amounts of sputum. Fever is as a rule absent. Roentgen examination of the chest usually shows a well defined area of infiltration, most often, but not necessarily, in the lower lung fields. The infiltration may be single or multiple, unilateral or bilateral, and is often completely resolved in one week's time. It may on occasion persist for four weeks or more. In some instances new areas of infiltration have appeared after the older areas have resolved. Pleural effusion has been reported. The pertinent laboratory findings are an eosinophilia varying from 10 to 80 per cent and an elevation of the erythrocyte sedimentation rate. The prognosis is uniformly good and the treatment that of the underlying condition.

## CASE REPORT

H. H., a white soldier, aged twenty-three, had the onset of his present illness on September 3, 1945, with a "cold" which persisted to admission on September 15. There was moderate nasal congestion, cough and the expectoration of yellow phlegm. He had had frequent night sweats but no chest pain or loss of weight. No chills or fever had been noted. In the past year, he had not felt completely well and complained mainly of weakness and intermittent headaches. The past history revealed pneumonia in December, 1942, and recurrence in January, 1943, three days after discharge from the hospital. His first attack of malaria occurred four weeks before the present admission. There was no history of allergic manifestations either in the patient or in his immediate family.

Physical examination on admission revealed a thin, pale soldier. There was capillary injection of the sclera and posterior pharynx. The remainder of the examination was not unusual.

Laboratory findings: September 17.

Malaria smear was negative. Complete urinalysis was normal. Hemoglobin 95 per cent (Sahli). Erythrocyte sedimentation rate 34 mm. per hour (Wintrobe). Twenty-four hour sputum examination—three specimens were negative for acid-fast bacilli. Three stool examinations were negative for ova and parasites. A fourth examination on September 27 was positive for cysts of *Endamoeba histolytica*. Proctoscopic examination showed a normal rectal wall.

Date	Total Leukocyte Count	Blood Counts		
		Neutro- phils	Eosino- phils	Lympho- cytes
		<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Sept. 17	7,100	61	14	14
Sept. 20	8,200	46	6	46
Sept. 24	10,600	77	9	13
Sept. 29	5,900	46	10	46

A roentgenogram of the chest taken on September 15 (Fig. 1) shows a well defined, ovoid



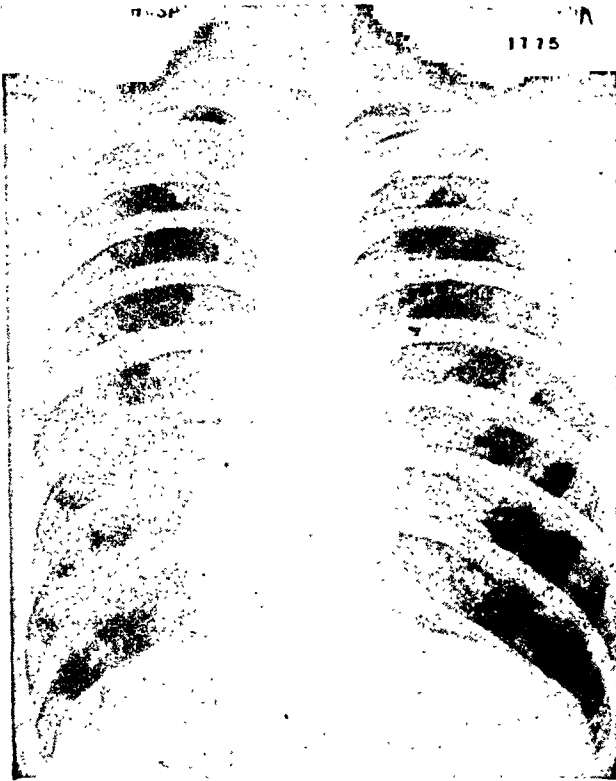


FIG. 1

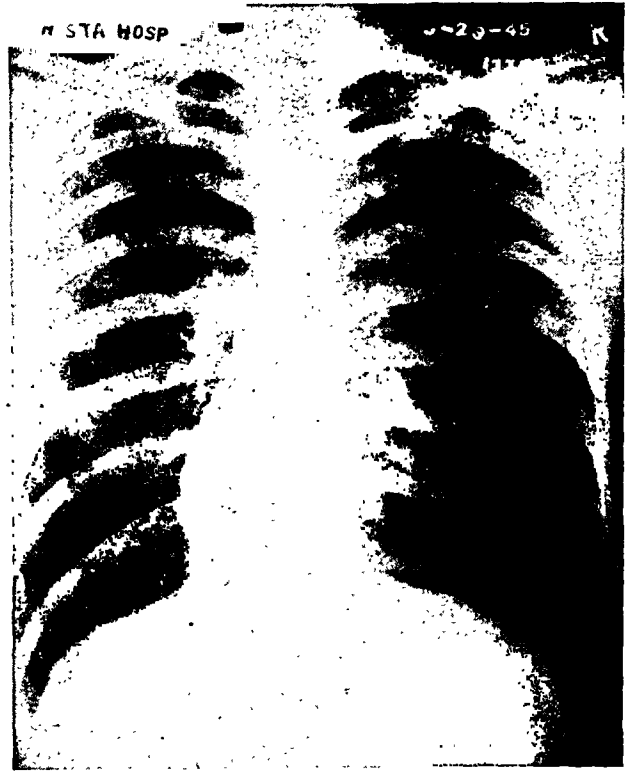


FIG. 2

area of increased density in the left lower lung field about the size of a silver dollar. There is an accentuation of the bronchovascular markings to the left lower lobe. A roentgenogram of the chest taken on September 24 (Fig. 2) shows that complete resolution of the infiltration has taken place.

*Course.* The patient was afebrile throughout. There was moderate cough and expectoration for the first few hospital days; thereafter he was asymptomatic. Carbarsone therapy was instituted on September 28 for amebiasis. Thereafter there was further subjective improvement.

#### DISCUSSION

A case of lung infiltration associated with eosinophilia and asymptomatic chronic amebiasis has been presented. At no time were the pulmonary symptoms more than minimal. The benign course, the rapid resolution of the lesion, and the blood findings fit in with the diagnosis of Loeffler's syndrome. It is suggested that many similar cases may be found in association with

infestations if more emphasis is placed on roentgen examinations of the chest, especially in the presence of cough, expectoration and chest pain.

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# ROENTGENOLOGIC CHARACTERISTICS OF DIAPHRAGMATIC HERNIA\*†

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## I. INTRODUCTION

ALTHOUGH diaphragmatic hernia has been known in the literature for several hundred years, the roentgenologic aspects of this condition are of fairly recent inception. The development of our present ideas about the roentgenographic and roentgenoscopic diagnosis of diaphragmatic hernia does not appear to be the work of one man or of a few men, but rather the composite effort of a great many men. In the period from 1910 to 1920 isolated case reports of diaphragmatic hernia diagnosed by roentgenologic means began to appear. Between 1913 and 1935 many significant articles appeared in the roentgenologic literature.<sup>1,2,6,9-11,19,30,31,33,40,42,46,49,56,62</sup> Roentgenologists, by this time, had seen enough cases to form a small series and with the publishing of their experiences and observations, a fund of information concerning the roentgenoscopic and roentgenographic diagnosis of diaphragmatic hernia was established. The contributions of later authors further added to the knowledge of diaphragmatic hernia.<sup>5,13-16,22-24,26,27,37,39,43,45</sup> These and many other noteworthy additions to the knowledge of diaphragmatic hernia have functioned to increase further the accuracy and usefulness of attempts to diagnose correctly all variations of this condition.

## II. EMBRYOLOGY

Some understanding of the fundamentals of the embryology of the diaphragm is a necessary prerequisite for accurate diagnosis.<sup>14,24,33,54</sup>

There are two important factors in the embryology of the diaphragm. They are (1) the source of the several components of the diaphragm and (2) the points in the diaphragm where these components fuse. The point of fusion is a place of weakness and is therefore a frequent site of diaphragmatic hernia.

The diaphragm may be considered as consisting of a membranous component and a muscular component. The membranous diaphragm is derived from a number of separate elements. First in importance among these is:

1. *The septum transversum.* This is made up of mesoderm and serves as an early but incomplete diaphragm. From this septum transversum or ventral mesentery are derived the membranous elements of the diaphragm which are ventral, or anterior, and central, including the portion of the diaphragm which is below the heart. The septum transversum by means of lateral segments also gives rise to the costal portion of the membranous diaphragm on each side.

2. The posterior and medial portion of the membranous diaphragm is derived from the *dorsal mesentery*. Embryologically this is the last portion of the diaphragm to form.

3. The posterior lateral elements of the diaphragm are derived from the paired *pleuroperitoneal membranes*. These membranes fuse laterally with the costal portion of the transverse septum and medially with the portions derived from the dorsal mesentery to complete the partition between the pleural and the peritoneal cavity.

4. The *thoracic wall* provides a small part

\* Read at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

† Abridgment of thesis submitted by Dr. Hodgson to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of M.S. in Roentgenology.

of the membranous diaphragm in the costal region bilaterally.

These four elements are therefore the source of the membranous diaphragm. Defects occurring in their development will result in defects in the diaphragm.

The muscular elements of the diaphragm are derived from two sources. Some invade the diaphragm at the level of the fourth cervical segment in 9 mm. embryos. There are also some muscle derivatives from the lateral body walls which form a component of the muscular elements of the diaphragm.

Therefore there are really four general groups into which the hernias through the diaphragm may be placed according to their embryologic development:

1. The foramen of Bochdalek, which is posterior and which is covered by the pleuroperitoneal membrane. It is a point of fusion and is a potential spot for diaphragmatic hernia.

2. The foramina of Morgagni, which are anterior on each side of the sternum and are a second potential weak spot in the diaphragm.

3. The esophageal hiatus in the muscle of the diaphragm on the left side. Failure of complete development of this hiatus may permit the herniation of the stomach through it.

4. Deficiencies of the other elements of the diaphragm. The embryologic development of any segment of the diaphragm may be stopped at any time. Variations of this process may result in complete absence of half of the diaphragm or small openings anywhere in the substance of the diaphragm.

### III. ANATOMY

For the purposes of discussion we shall divide the diaphragm into three elements according to their anatomic origin.

A. The *sternal portion* arises from the posterior surface of the xiphoid process and consists of a pair of short, narrow muscular slips that pass backward and upward to be inserted into the central tendon.

B. The *costal portion* of the diaphragm

arises from the inner surfaces of the lower six costal cartilages and inserts into the anterolateral borders of the central tendon or aponeurosis.

C. The *vertebral portion* of the diaphragm arises from the lateral and ventral sides of the bodies of the first three lumbar vertebrae. This portion of the diaphragm will be considered as two distinct elements for the purpose of simplification. These are, (1) the crura and (2) the arcuate ligaments.

1. The *crura* are a pair of musculotendinous elements arising from the first, second and third lumbar vertebrae on the right and from the first and second lumbar vertebrae on the left. The left margin of the right crus is directed obliquely upward and to the left in front of the aorta. It splits as it approaches the central tendon to form an elliptical opening for the esophagus. Thus the esophageal opening is surrounded by a sphincter-like arrangement of this muscle. The left crus is more variable in size and attachments than the right crus and is usually smaller.

2. There are two *arcuate ligaments*—medial and lateral. The *medial* arcuate ligament runs laterally and posteriorly from the aorta and gives off fibers which join the right crus as it splits to encircle the esophagus.

The *lateral* arcuate ligament arises from the transverse process of the first or second lumbar vertebra and arches across the upper part of the quadratus lumborum to be attached to the eleventh or twelfth rib.

The superior border of these ligaments gives rise to muscular fibers which make up a part of the posterior segment of the diaphragm and which are inserted into the central tendon.

The opening in the diaphragm for the esophagus is of great interest to the roentgenologist. Harrington<sup>24</sup> in his excellent monograph on this subject has emphasized the importance of the anatomy of the esophageal opening in the diaphragm.

Harrington pointed out that the diaphragmatico-esophageal membrane and the loose attachment of the peritoneum at the

cardia are extremely important in the development of hiatus hernias. Harrington further stated that the hiatus hernias of elderly people which are accompanied by insufficiency of the hiatus are probably due in part to atrophy of this protective elastic membrane especially where, to begin with, there may be an abnormally large hiatus. Another factor which might also be considered with the atrophy of age is the general tendency toward obesity of people in this group, which may have some effect on the development of diaphragmatic hernia of the hiatal variety.

#### IV. CLASSIFICATION

Many classifications have been devised for diaphragmatic hernia. In fact their number is almost equal to the list of articles on the subject. The ideal classification would be that which is very simple and yet contains a maximum of information.

Harrington<sup>24</sup> has proposed what seems to us to be the most complete classification of these lesions. It combines the various elements in such a way as to be most informative to the surgeon, the clinician and the roentgenologist. We have added eventration, although it is not a hernia, since we wish to discuss the differential diagnosis of this condition from hernia.

##### A. Diaphragmatic hernia

##### I. Nontraumatic lesions

##### a. Congenital

1. Pleuroperitoneal (foramen of Bochdalek)
2. Esophageal hiatus (congenital type)
  - (a) Para-esophageal
  - (b) Esophageal hiatal
3. Short esophagus
  - (a) Congenital short esophagus
4. Anterior substernal (foramen of Morgagni-Larrey's spaces)
5. Gaps in or partial absence of the diaphragm (posterior portion of the diaphragm)
6. Complete absence of hemidiaphragm

##### b. Acquired

1. Esophageal hiatus
  - (a) Pulsion type
    - (1) Similar to para-esophageal
    - (2) Similar to esophageal hiatal

##### 2. Short esophagus

- (a) (Not congenital) ulceration and cicatricial contraction which draws the stomach above the diaphragm.

##### 3. Through regions of fusion of the anlage of the diaphragm

##### 4. At sites named in the congenital type

#### II. Traumatic

##### a. Indirect injury

1. Anywhere in the diaphragm
2. Points of embryologic fusion
3. Dome and posterior half of the diaphragm

##### b. Direct injury

1. Any point in the diaphragm

##### c. Result of inflammatory necrosis

1. Subdiaphragmatic abscess or drainage tubes
2. Usually posterior portion of the diaphragm

#### B. Eventration

In this paper we shall not follow this classification in exact order. For the purposes of clarity all esophageal hiatal hernias will be discussed together.

#### V. INCIDENCE

Ideas concerning the incidence of diaphragmatic hernia have changed with the advent of their more frequent diagnosis. This is especially true of esophageal hiatal hernias, which were formerly thought to be quite rare.<sup>16</sup>

Harrington<sup>24</sup> reported the incidence of diaphragmatic hernia based on 250 cases in which operation had been done between 1926 and 1940: esophageal hiatal hernia, 198; pleuroperitoneal hiatal hernia, 4; congenital absence of portion of left side of the diaphragm, 4; foramen of Morgagni hernia, 4; traumatic herniation through dome, 40. Thus he concluded that esophageal hiatal hernia treated surgically was about four times as common as all other types of herniation combined.

Harrington and Kirklin<sup>27</sup> reported that at the Mayo Clinic between 1900 and 1925 thirty cases were recognized and 19 patients were operated on. From 1925 to 1937, 211 cases were recognized and 131 patients were operated on.

In a series of 5,269 necropsies on stillborn infants and infants up to one year of age,

from the Department of Pathology of the University of Minnesota, Haugen and Ehrenberg<sup>29</sup> found 38 diaphragmatic hernias or one hernia in 139 necropsies.

We found on examination of our records at the Mayo Clinic that diaphragmatic hernias of all types occur with a frequency of between 1 and 2 per cent of all gastrointestinal examinations.

#### VI. CLINICAL ASPECTS

Before the advent of roentgenology, the diagnosis of diaphragmatic hernia was extremely difficult and rarely made. A discussion of the complete nature of the clinical aspects of diaphragmatic hernia is outside the scope of this paper. However, the close relationship between certain of the symptoms and the roentgenoscopic diagnosis requires a brief consideration of some of the clinical features of diaphragmatic hernia. For more complete information regarding this aspect of diaphragmatic hernia the reader is referred to articles by Polley,<sup>50</sup> Giffin,<sup>21</sup> Harrington<sup>24</sup> and others.<sup>27</sup>

Some diaphragmatic hernias are symptomless. In others the symptoms are very slight. Variable symptomless periods are common and are probably due to temporary spontaneous reduction of the hernia.

In the traumatic type of diaphragmatic hernia a history of injury is of importance. Diaphragmatic hernias may not develop coincident with the injury but may present themselves at a later date. Carman and Fineman<sup>10</sup> suggested that this type of diaphragmatic hernia may not develop until months or years after the injury.

Harrington and Kirklin<sup>27</sup> have stated that the symptoms depend on three factors. (1) the mechanical interference with herniated viscera, (2) interference with function of the diaphragm and (3) the amount of increased pressure within the thorax.

The most frequently encountered symptom in cases of diaphragmatic hernia is substernal pain.<sup>50,53</sup> Other symptoms described are nausea and vomiting, bloating and belching, heartburn and dysphagia, and dyspnea.

The physical signs of diaphragmatic hernia are highly variable. The roentgenogram of the thorax is of much more definitive value than physical signs.

Bleeding occurs in a certain number of cases of diaphragmatic hernia.<sup>7,20,50,58</sup> It is due to the erosion and ulceration of gastric mucous membrane within the hernia. The erosion and ulceration is on the basis of a chronic or recurrent venous congestion. A certain amount of pressure is exerted by the margins of the hernia on the vascular supply. This produces the venous congestion, which in turn is the precursor of a chronic inflammatory state of the gastric mucous membrane.

#### VII. ESOPHAGEAL HIATAL HERNIA

Prior to the appearance of articles on hiatal hernia in the decade 1920 to 1930 it had been felt that esophageal hiatal hernia was an extremely rare lesion.<sup>16</sup> Subsequent investigation has shown that esophageal hiatal hernia is the most common type of diaphragmatic hernia. In a review of the cases in which diaphragmatic hernia was diagnosed roentgenologically for the year 1944 at the Mayo Clinic, we found that diaphragmatic hernia at the esophageal hiatus represented more than 98 per cent of all the cases of diaphragmatic hernia. All diaphragmatic hernias occur with a frequency of between 1 and 2 per cent of all gastrointestinal examinations.

Jackson and Jackson<sup>34</sup> stated that hiatal hernia is a rather common condition in their records. Åkerlund<sup>2</sup> in 1926 showed that esophageal hiatal hernia is six to seven times more frequent than the other varieties. In 1940 Harrington<sup>24</sup> reported 250 cases in which treatment was surgical, of which 187 were of the esophageal hiatal type. In addition there were 11 cases of the short esophagus type. Of our 306 cases in which esophageal hiatal hernia was diagnosed roentgenologically in 1944, 31 were of the short esophagus type and an additional 51 cases presented what appeared to be a shortened esophagus. There has been much confusion over the use of the term

"short esophagus." In order that there may be no misunderstanding, we shall attempt to clarify our interpretation of these terms now.

There are a number of types of hernia present at the esophageal hiatus. For the purposes of simplification we shall discuss the hiatal hernias as a group, including those lesions which are not true hernias and also those lesions which may be acquired,

whose straight short esophagus ended at the third costal cartilage and in whom there was no evidence that the stomach had herniated through the diaphragm. In cases of congenitally short esophagus with thoracic stomach the stomach has not herniated through the esophageal hiatus of the diaphragm, since it never was below the diaphragm at any time. The thoracic position of the stomach is due to the failure of the

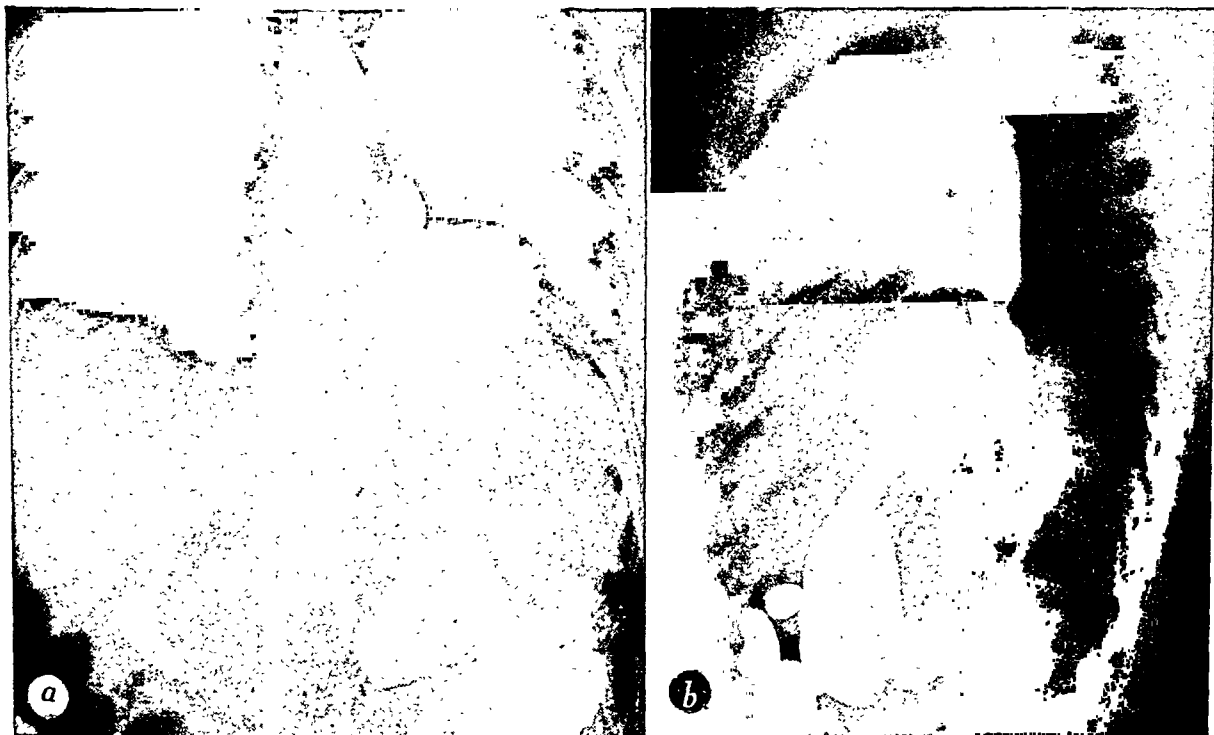


FIG. 1. Congenitally short esophagus in the case of a forty-four year old woman. *a.* Esophageal hiatal hernia containing five-sixths of the stomach, a loop of transverse colon and a portion of the spleen. The esophageal hiatus was extremely large (12 cm.) and at operation the surgeon felt that this was probably a true congenitally short esophagus. The roentgenogram shows a large part of the stomach above the diaphragm. *b.* Lateral view of the thorax.

as well as congenital. An outline of these lesions is as follows: (1) congenitally short esophagus with thoracic stomach, (2) hiatal esophageal hernia with shortened esophagus, (3) esophageal hiatal hernia and (4) para-esophageal hernia through the esophageal hiatus.

*Congenitally Short Esophagus with Thoracic Stomach.* This is a very rare lesion. Bailey<sup>3</sup> first proposed the term describing this type of lesion after postmortem examination of a seventy-seven year old man

stomach to migrate caudad, to failure of the esophagus to maintain its longitudinal growth or, according to Jackson and Jackson,<sup>34</sup> to a congenitally large esophageal hiatus (Fig. 1).

The term "thoracic stomach" should be used only in conjunction with congenitally short esophagus. A survey of the literature reveals much confusion regarding this term and numerous articles have been published on conditions which are merely various types of diaphragmatic hernia masquerad-



FIG. 2. Esophageal hiatal hernia in a fifty-four year old woman with slight redundancy of the lower part of the esophagus.

ing under the name of "thoracic stomach."

*Esophageal Hiatal Hernia with Shortened Esophagus.* This represents 26 per cent of all esophageal hiatal hernias. By using the word "shortened" we imply that at one time the esophagus was longer but that it has now become shortened. Frequently what appears to be a short esophagus in the roentgenoscopic and roentgenographic examination of the upper part of the gastrointestinal system will prove to be capable of a considerable amount of stretching by the surgeon at operation. When diaphragmatic hernia occurs, a certain amount of redundancy of the lower part of the esophagus is present. It is possible that the normal muscle tone of the longitudinal muscle fibers of the esophagus adjusts itself to a state of contraction of these fibers which produces the apparent shortening of the esophagus. It is impossible to determine from roentgenoscopic and roentgenographic examination alone whether the apparently shortened esophagus is capable of being stretched or not. We feel that this shortening should be mentioned in the re-

port of the diaphragmatic hernia, however, since it may provide valuable information to the surgeon attempting repair.

On the other hand, in some of these cases the shortened esophagus may prove to be a congenitally short esophagus. Unfortunately the roentgenologist has no accurate method of determining which of these esophaguses are incapable of stretching and which are really congenitally short. Even knowing how infrequently congenitally short esophagus occurs it is still impossible to determine accurately in the individual case whether the esophagus is *short* or *shortened*.

*Esophageal Hiatal Hernia.* This type of hernia at this site refers to those cases in which the esophagogastric junction is above the diaphragm and both the stomach and the lower end of the esophagus are contained in the hernia (Fig. 2). This is the most common type of hernia encountered at the esophageal hiatus and represents 66.5 per cent of the group of esophageal hiatal hernias examined roentgenologically at the Mayo Clinic in 1944. In this group there is usually slight to marked redundancy of the lower part of the esophagus as distinguished from the shortened esophagus type. The only difference between this group and the group of esophageal hiatal hernias with shortened esophagus is the apparent length of the esophagus. They are otherwise the same.

*Para-Esophageal Hernia through the Esophageal Hiatus.* This is the type of hernia in which a portion of the stomach herniates through the esophageal hiatus of the diaphragm but the esophagogastric junction remains below the diaphragm and no esophagus is present within the hernia (Figs. 3 and 4). This group represents 7.5 per cent of all the esophageal hiatal diaphragmatic hernias examined roentgenologically at the Mayo Clinic in 1944. Any part of the stomach may be involved in this hernia. It is more frequently the cardia but we have encountered cases in which the midportion of the stomach and also the pyloric segment of the stomach were involved.

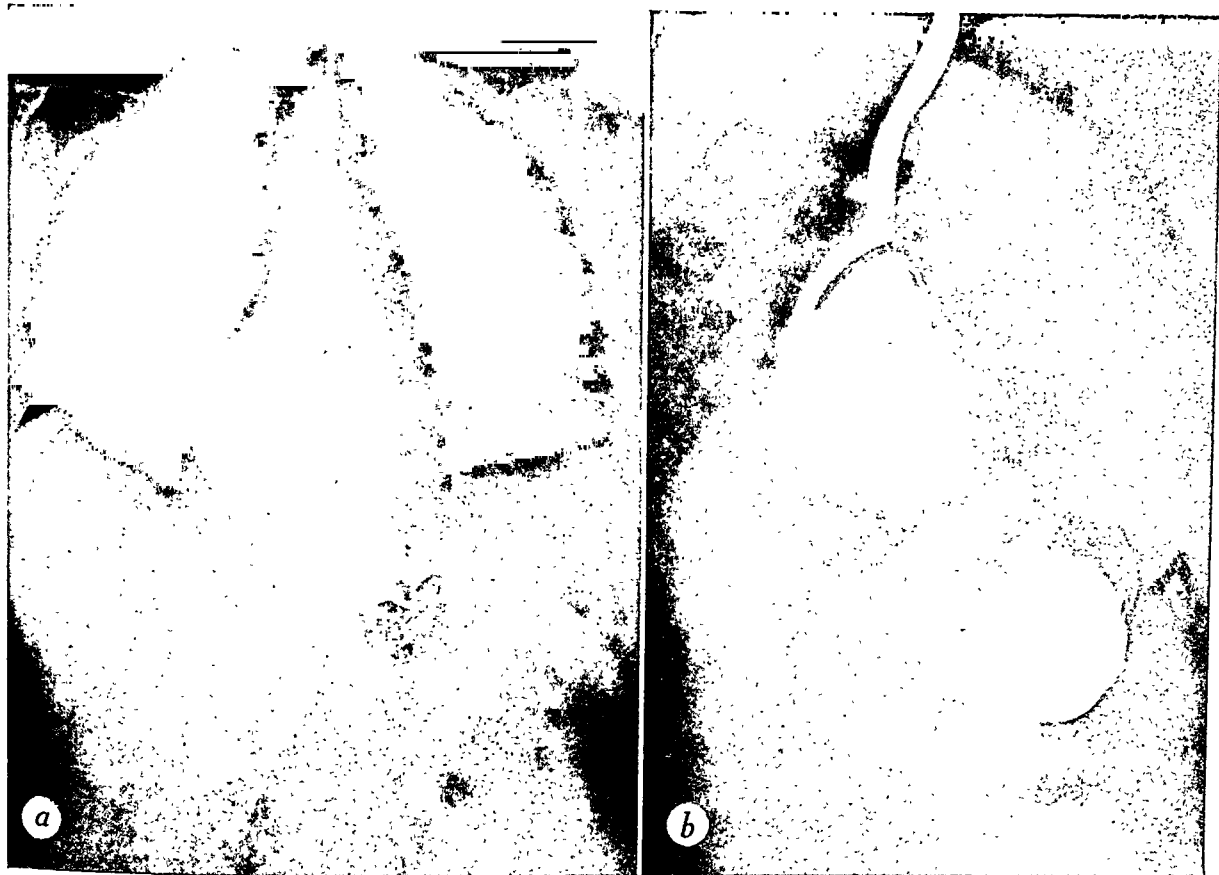


FIG. 3. Para-esophageal hernia at the esophageal hiatus in the case of a sixty-four year old woman. *a*. The cardiac half of the stomach has herniated through a defect in the posterior portion of the esophageal hiatus. *b*. Lateral roentgenogram which demonstrates the course of the esophagus with the esophagogastric junction below the diaphragm and also emphasizes the importance of the lateral view.

Inflammatory processes in the esophagus in which cicatricial changes develop with resultant narrowing and gradual shortening may produce hiatal hernias. These fibrosing changes with resultant shortening produce hiatal hernias by a gradual pulling up of the esophagus which causes the herniation of a small portion of the cardiac end of the stomach through the esophageal hiatus (Fig. 5). One example of this condition is scleroderma of the esophagus, which has been described by Olsen, O'Leary and Kirklin.<sup>47</sup> In this disease the mucosa is involved and inflammation supervenes fol-



FIG. 4. Para-esophageal hernia at the esophageal hiatus in the case of a sixty-eight year old woman. The esophagogastric junction is below the diaphragm. The cardiac end of the stomach has herniated through the esophageal hiatus.





FIG. 5. Shortening of the esophagus with esophageal hiatal hernia in the case of a fifty-four year old man who had had trouble in swallowing for four to five years. Esophagoscopy revealed chronic esophagitis with stricture at the esophagogastric junction. It is probable that the chronic inflammatory process of the esophagus has caused shortening of the esophagus and subsequent development of the hernia. *a*. Notice the irregularity of the mucous membrane at the esophagogastric junction. *b*. Lateral view.

lowed by ulceration and scar tissue with cicatrix formation. Other inflammatory conditions involving the esophagus will also produce these changes. Examination of our records of esophageal hiatal hernia show that mediastinal tumors may cause displacement of the esophagus with resultant small esophageal hiatal hernias. Carcinoma of the esophagus with some inflammatory component frequently causes shortening with the production of small esophageal hiatal hernias (Fig. 6). Marked cardiac enlargement, if it causes esophageal displacement, may be an etiologic agent for small esophageal hiatal hernias. Ulcers of the esophagus from various causes and lesions which will produce upward traction on the esophagus must be considered as factors in the production of esophageal hiatal hernias.

We shall consider the congenital and acquired esophageal hiatal hernias together. They are definitely related and probably

the greater percentage of this group are a combination of a congenital or developmental insufficiency with an acquired factor. Congenital defects at or near the esophageal hiatus sufficient to produce a hernia are probably not any more common than congenital defects in other parts of the diaphragm.

Harrington<sup>27</sup> routinely examined the esophageal hiatus in the course of operation on the abdomen in 1,000 consecutive cases at the Mayo Clinic. He found that in 55 per cent of these cases the esophageal hiatus closely approximated the lower end of the esophagus. In 35 per cent one finger could be inserted between the esophagus and the margins of the esophageal hiatus. In 8 per cent two fingers could be inserted and in 2 per cent two to three fingers could be placed between the esophagus and the edge of the esophageal opening.

Another important element in the development of the esophageal hiatal type of

hernia is the age of the patient. Harrington<sup>24</sup> has pointed out that the esophago-gastric membrane is susceptible to atrophy, as is any other part of the body, and therefore atrophy of these fibers may result in a relative insufficiency of the esophageal hiatus.

Ritvo,<sup>56</sup> in a review of 60 cases, has listed the ages of the patients who had diaphragmatic hernia. His results are given in Table I.

Our figures for a group of 306 cases of esophageal hiatal hernia for the year 1944 at the Mayo Clinic are given in Table II.

There is slight variation. Our largest number of cases occurred between the ages of fifty and fifty-nine years, while Ritvo's greatest percentage fell in the forty-one to fifty year age group. It is interesting to note that in 92 per cent of our cases the esophageal hiatal hernia occurred after forty years of age.

Esophageal hiatal hernia occurs approximately twice as frequently in women as in men. This is in accord with Ritvo's conclusions. In his 60 cases, 41 patients were

TABLE I

AGE OF PATIENTS WHO HAD DIAPHRAGMATIC HERNIA  
(RITVO'S EXPERIENCE)

Age, Years	Cases	Per Cent
21-30	4	6.6
31-40	8	13.4
41-50	18	30.0
51-60	16	26.7
61-72	14	23.3

TABLE II

AGE OF PATIENTS WHO HAD ESOPHAGEAL HIATAL  
HERNIA (OUR EXPERIENCE)

Age, Years	Cases	Per Cent
20-29	4	1.3
30-39	20	6.5
40-49	57	18.6
50-59	124	40.6
60-69	78	25.5
70-79	20	6.5
80-89	3	1.0



FIG. 6. Squamous cell epithelioma of the esophagus with esophageal hiatal hernia in the case of a fifty-nine year old man. There is an associated esophageal hiatal hernia. Gastric mucosa may be seen above the diaphragm in the roentgenogram. The esophageal hiatal hernia is probably secondary to changes brought on by the carcinoma of the esophagus.

women and 19 were men. In our series of cases, 203 were women and 103 were men.

Another important factor in the production of esophageal hiatal hernia is obesity. Harrington<sup>26</sup> has pointed out that he has long considered obesity as a predisposing factor in the development of hiatal hernia. A search of the literature and an analysis of our cases reveals that this type of lesion occurs most frequently in obese middle-aged women.

Childbearing has been found to have a definite relationship to the development of esophageal hiatal hernia. Rigler and Eneboe<sup>55</sup> in 1935 concluded that increased intra-abdominal pressure, such as is pro-

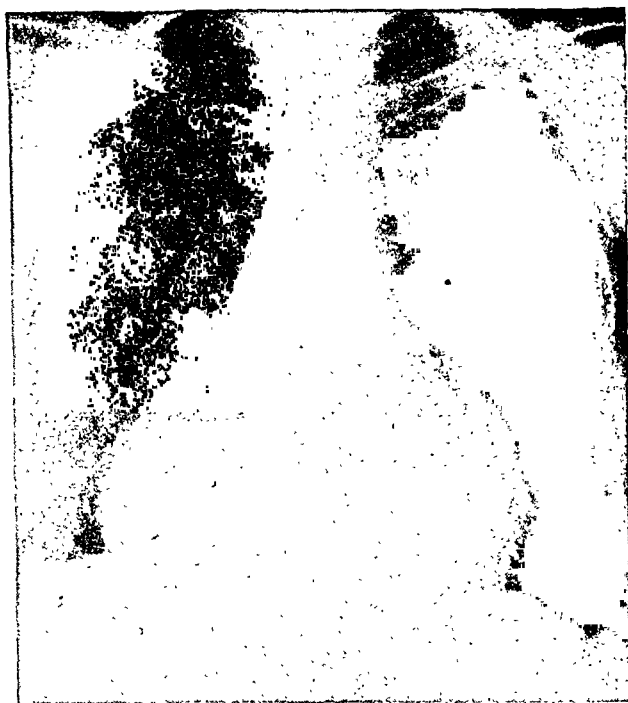


FIG. 7. Large esophageal hiatal hernia with fluid level in the stomach seen in the roentgenogram of the thorax.

duced by pregnancy, especially when repeated, appears to be an important inciting cause for the production of esophageal hiatal hernias. In 1940 Evans and Bouslog<sup>17</sup> presented data on 4 pregnant women with severe "heartburn," all of whom had small hiatal hernias revealed by roentgenoscopic examination of the stomach.

There are a number of important points in the roentgenoscopic diagnosis of esophageal hiatal hernia. Each one will be discussed separately. If the hernia is large the diagnosis will not be difficult (Fig. 7). We shall concern ourselves with the diagnosis of small esophageal hiatal hernias.

First, the basic point of orientation in the diagnosis of esophageal hiatal hernia is the *esophagogastric junction*. The exact location of this basic point must be established in order to make an accurate diagnosis. If the esophagus is seen emptying into a large saccular portion of the stomach above the diaphragm the diagnosis is obvious. If, however, the hernia is small the exact location of the esophagogastric junction may not be so easily seen. The esophagogastric junction, in small esophageal hiatal her-

nias, must be differentiated from a peristaltic wave passing down the lower part of the esophagus. The point of differentiation is, of course, the constancy of the esophagogastric junction as opposed to the transitory nature of a peristaltic wave of the lower part of the esophagus. The location of the esophagogastric junction should be demonstrated to the satisfaction of the roentgenoscopist before roentgenograms of the hernia are made. Turning the patient in the various oblique positions is, of course, helpful. This is especially true when one is dealing with a para-esophageal hiatal type of hernia, in which the esophagogastric junction is below the diaphragm with a variable segment of stomach above the diaphragm.

The second point in the diagnosis of esophageal hiatal hernia is the retardation of the barium stream at the esophageal hiatus. This has been described by Morrison.<sup>46</sup> Morrison stated that normally the fluid column remains 2 to 3 inches (5 to 8 cm.) high in the lower part of the esophagus when barium is rapidly ingested. In nearly all cases of hernia the barium column remains 4 to 5 inches (10 to 13 cm.) high at the same rate of ingestion. Retardation of the barium stream should lead the roentgenoscopist to suspect the presence of hernia.

The third point in diagnosis of esophageal hiatal hernia is tortuosity of the lower part of the esophagus without dilatation. In reviewing our cases in which diaphragmatic hernia was diagnosed roentgenologically for the year 1944 we found that in more than a third of all esophageal hiatal hernias there was some degree of tortuosity of the esophagus without dilatation. If the esophageal hiatus is insufficient and hernia occurs there may be redundancy of the lower part of the esophagus which produces the tortuosity. Redundancy of the lower part of the esophagus with esophageal hiatal hernia is probably found early in the development of certain types of esophageal hiatal hernias. In close association with tortuosity of the lower part of the esoph-

agus is angulation of the lower part of the esophagus. This is especially true in the para-esophageal type of hiatal hernia where the herniated stomach causes displacement of the lower end of the esophagus.

Various techniques have been devised for better demonstration of the hernia while the patient is undergoing roentgenoscopic examination. The patient may be asked to take three swallows of barium mixture and to strain. This accomplishes two things: first, the deep breath produces a reduction of intrathoracic and intra-esophageal pressure and, second, straining raises the intra-abdominal pressure and aids in the demonstration of the hernia. This maneuver is simple and easily explained to the patient and occasionally produces the effect desired. Various other maneuvers, such as the Mueller test and the Valsalva test, have been described as producing the same effect. As a general rule these techniques have not proved to be of much value in the demonstration of esophageal hiatal hernias in our experience.

The position of the patient during the examination is also important. The best view of the lower part of the esophagus and the upper part of the stomach is obtained by turning the patient slightly to his left before the ingestion of the barium mixture. This will give the roentgenoscopist an unobstructed view of the lower part of the esophagus and the cardia of the stomach as the first swallow of the barium mixture reaches this region.

Our experience has led us to believe that changes which betray the presence of esophageal hiatal diaphragmatic hernia may almost always be seen with the patient in the upright position. In cases of doubt it is probably good policy to examine the patient in the horizontal position. Straining will sometimes make the borders of the hernia apparent with the patient in the horizontal position when the hernia is not very well seen in the upright position. Occasionally an esophageal hiatal hernia will not be seen in either position owing to spontaneous reduction of the hernia, when it

has definitely been present on previous examinations.

Two roentgenograms of the patient are made. The patient lies recumbent on the table and a wooden support is placed under the right side in order to raise it approximately 15 degrees from the table top. A definite procedure is followed in obtaining the roentgenograms. A large paper cup containing a mixture of barium and water is given to the patient and he is instructed to drink half of the contents of the cup rapidly, then take a deep breath and strain with the abdominal muscles. At precisely this instant the roentgenogram is made. The average technical factors are as follows: 67 kv., 150 ma., target film distance, 38 inches; time, 0.3 second. The Potter-Bucky diaphragm is used.

The same procedure is used in obtaining the second roentgenogram except that the patient lies flat on his back. The patient is strapped to the table to aid in preventing motion and care should be taken to avoid motion as much as possible. It is more important to have the patient ingest a sufficient quantity of barium mixture than to be concerned about the straining of the patient. As a matter of fact the usefulness of straining in an attempt to produce the hernia may be questioned.

If the roentgenograms are at variance with the roentgenoscopic impression it is well to repeat the examination.

If the hernia is large enough it may be possible to demonstrate gastric mucosal folds in the roentgenogram of the herniated portion of the stomach. However, when the hernia is small and the mucosal folds of the stomach run parallel to those of the esophagus it becomes very difficult to use the appearance of the mucosal pattern of the stomach as a factor in making the diagnosis of esophageal hiatal hernia. Some confusion may arise between a cone-shaped dilatation of the lower end of the esophagus and a small esophageal hiatal hernia. If the location of the esophagogastric junction has been definitely determined roentgenoscopically, however, the interpretation of the



FIG. 8. Ulceration in an esophageal hiatal hernia in the case of a fifty-six year old man. A rather large portion of the stomach may be seen above the diaphragm. There is an ulcer at the esophagogastric junction. The esophagus is shortened. The presence of the ulcer was confirmed by esophagoscopy.

roentgenograms should not be difficult.

In reviewing our cases of esophageal hiatal hernia we divided the hernias into various groups depending on their size. In one group, which represented 73 per cent, we placed all those cases in which the hernia involved less than 3 inches (8 cm.) of stomach above the diaphragm. In a second group, which represented 20 per cent, we placed those in which the hernia involved 3 to 5 inches (8 to 13 cm.) of stomach. In the third group, which represented 7 per cent, more than 5 inches (13 cm.) of stomach was involved in the hernia.

Thus most of the esophageal hiatal hernias are small. However, we do feel that their early diagnosis is extremely important.

Ulcers of the stomach in cases of diaphragmatic hernia may be located in any region of the herniated stomach. They may be found at the esophagogastric junction (Fig. 8) or along the lesser curvature of the

stomach. There is no specific location for their occurrence. They are not common in cases of esophageal hiatal hernia although esophagoscopists report that small superficial erosions of the gastric mucous membrane are found fairly frequently in this type of diaphragmatic hernia.<sup>34</sup> The ulcers may or may not perforate. It is obvious that the hernia is more likely to be incarcerated if an ulcer is present than if it is absent. Rude<sup>57</sup> expressed the opinion that the constricting effect of the margins of the diaphragm on the herniated stomach is probably instrumental in the causation and development of the gastric ulcer in the hernia.

#### VIII. FORAMEN OF MORGAGNI HERNIA

This type of diaphragmatic hernia, also called "parasternal" or "costosternal hernia," occurs fairly infrequently. The parasternal space, Larrey's space or the foramen of Morgagni is a bilateral, retrosternal, muscle-free triangle which is covered by peritoneum below and pleura above. Its three borders are anteriorly the sternum, medially the sternal portion of the diaphragm and laterally the costal portion of the diaphragm. These hernias may be either bilateral or unilateral. Both types have been described.<sup>44</sup> These hernias have a sac. In bilateral hernias there may be stomach on one side and colon on the opposite side (Fig. 9).

Harrington<sup>25</sup> stated that this type of hernia is the least common type of hernia that he has operated on. He also suggested that this type of hernia is essentially congenital in origin although it may not be present at birth. It develops later in life owing to the effect of markedly increased intra-abdominal pressure on a developmental defect in the diaphragm.

The roentgenologic findings are those of the appearance of abnormal shadows near the midline in the bases of the roentgenograms of the thorax (Fig. 10). Shadows in the cardiophrenic angles which do not appear to be completely outlined within the thorax must be differentiated from costo-

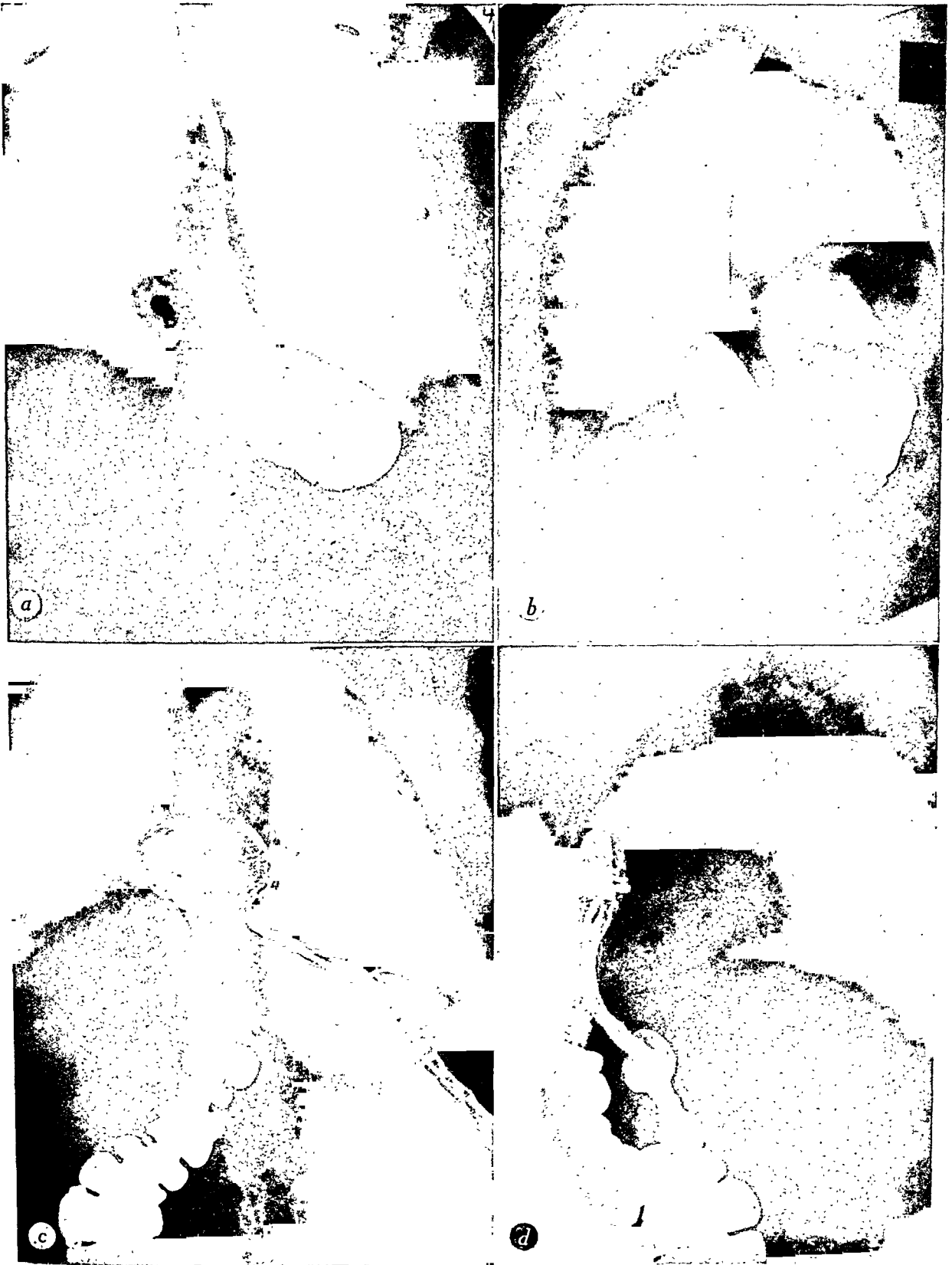


FIG. 9. Bilateral foramen of Morgagni hernias in the case of a fifty-four year old woman. *a.* Pyloric end of the stomach in the right-sided hernia. There is also a small esophageal hiatal hernia. *b.* Lateral view; the pyloric end of the stomach herniating through the right foramen of Morgagni and a small esophageal hiatal hernia. *c.* Colon in a left-sided foramen of Morgagni hernia. *d.* Lateral view; herniation of the colon through the left foramen of Morgagni.



FIG. 10. Foramen of Morgagni hernia in the case of a fifty-one year old woman. *a*. The roentgenogram of the thorax reveals a triangular shadow in the cardiophrenic angle on the right side. The patient had never had any symptoms referable to this lesion; at operation she was found to have a foramen of Morgagni hernia containing omentum. *b*. Lateral view of the thorax. Note the well-circumscribed anterior mass which is not entirely outlined within the thorax.

sternal hernia. A lateral roentgenogram is especially useful in this type of hernia. If the mass is anterior and in close conjunction with the diaphragm, further information may be obtained by the roentgenoscopic examination of the alimentary tract. More frequently this type of hernia contains colon. Occasionally when this type of diaphragmatic hernia contains omentum only, it may simulate closely a pulmonary tumor and it may be impossible to distinguish roentgenologically between tumor and hernia.

The lateral roentgenogram of the thorax may reveal that the contents of the hernia contain fluid and gas which is strong suggestive evidence of the presence of this type of hernia. Frequently the outlines of the colon with its haustral markings may be seen in the anteroposterior roentgenograms of the thorax. This type of diaphragmatic hernia may simulate many types of lesions. It is frequently associated with changes in the lung. Colmers<sup>12</sup> reported a case of right-

sided parasternal hernia with acquired total atelectasis of the middle lobe of the right lung. The hernia may simulate fluid in the pleural space, pleural thickening, tumor, atelectasis and many other lesions and it must be considered in the differential diagnosis of most of the lesions occurring in the bases of the lungs. Fortunately the parasternal type of hernia is rare. If there is sufficient reason to suspect the lesion, examination of the intestinal tract with opaque mediums will usually be of help in arriving at a diagnosis.

#### IX. PLEUROPERITONEAL HERNIA

This type of diaphragmatic hernia, also called hernia through the foramen of Bochdalek, is a hernia through the posterior segment of the diaphragm. Developmentally this is a weak spot and a point of fusion in the membranous diaphragm. In the early embryologic development of the diaphragm the pleuroperitoneal canals are located in this region. These provide a communicating

canal between the peritoneal and pleural cavities. Normally these canals close by ingrowth from their walls to form the pleuroperitoneal membrane. If the pleuroperitoneal canals should remain open, then the increased intra-abdominal pressure would force viscera into the thoracic cage

These hernias are present at birth. Harrington<sup>24</sup> has stated that many infants suffering from this condition die in the first few days of life because of respiratory and cardiac embarrassment before treatment can be instituted. Carter<sup>26</sup> in discussing an article by Harrington stated that 75 per

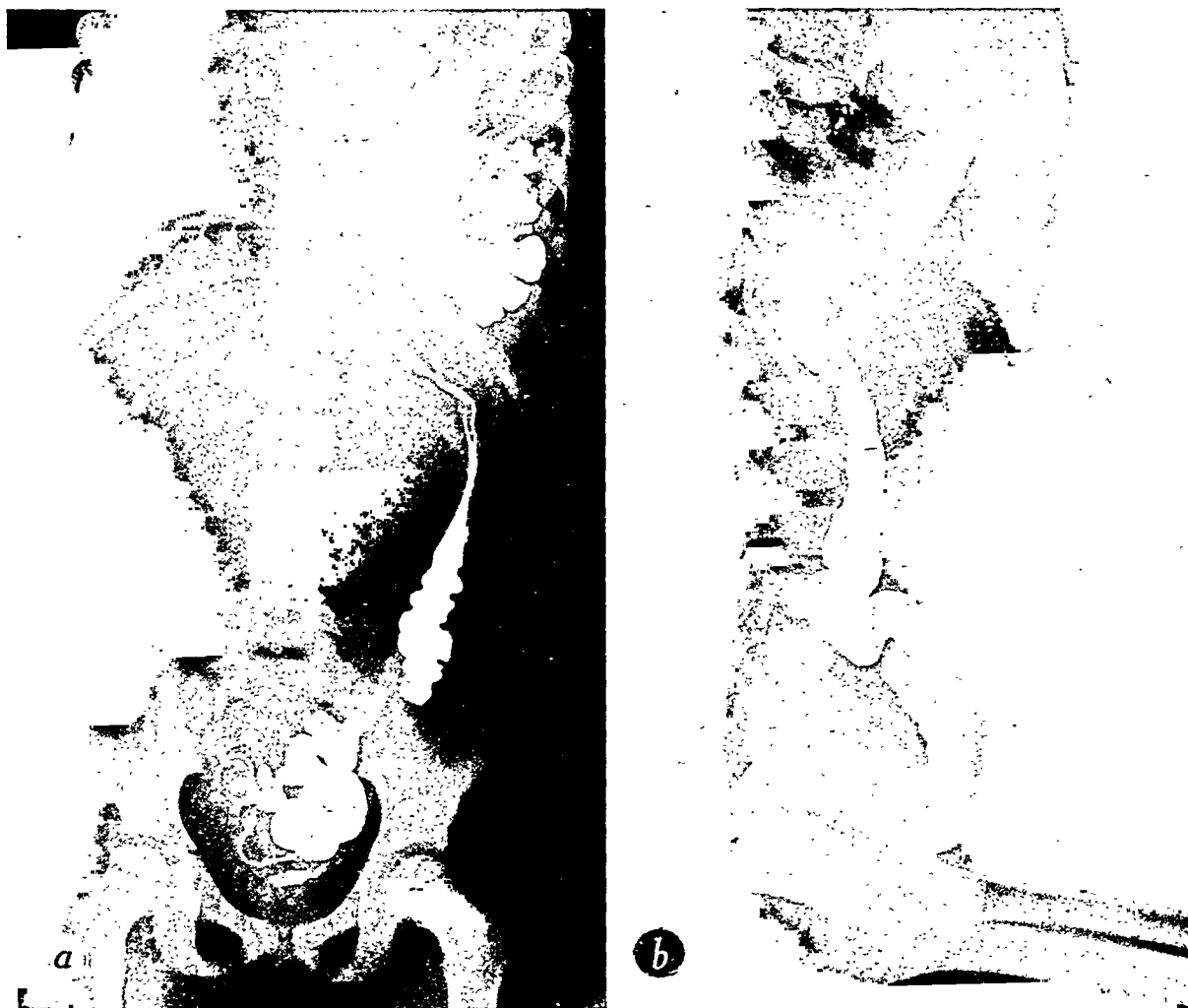


FIG. 11. Pleuroperitoneal hernia in the case of a one year old girl. *a*. Segment of colon above the left diaphragm. At operation the colon and small bowel were found to be herniated through a fairly small opening at the pleuroperitoneal hiatus. *b*. Lateral view of the thorax. Note the numerous loops of small intestine.

and a so-called false hernia would occur. However, if the pleuroperitoneal canals close and a hernia occurs in this region then the sac would be made up of layers of pleura and peritoneum and a true hernia would result. This weak spot in the diaphragm persists as the muscular elements invade the diaphragm because it then becomes the junction for two separate muscular elements.

cent of infants who have congenital hernia through the diaphragm die before the end of the first month of life. A further number of the remaining 25 per cent die early in childhood. The importance of early diagnosis cannot be overemphasized. Respiratory or cardiac embarrassment in newborn infants is usually sufficient indication for roentgenographic examination of the thorax and the possibility of congenital diaphrag-



matic hernia must always be kept in mind by the roentgenologist.

Several cases have been described in which the patient was an adult. Commonly these patients complain of epigastric pain which may be associated with gastrointestinal upsets or constipation. The contents of this type of hernia most frequently

gram located behind the heart must be considered as possible hernias. Sometimes the haustral markings of the colon or small bowel may be visible in the roentgenogram of the thorax.

Roentgenoscopic examination of the stomach, small bowel and colon should be done in suspected cases, to attempt to de-

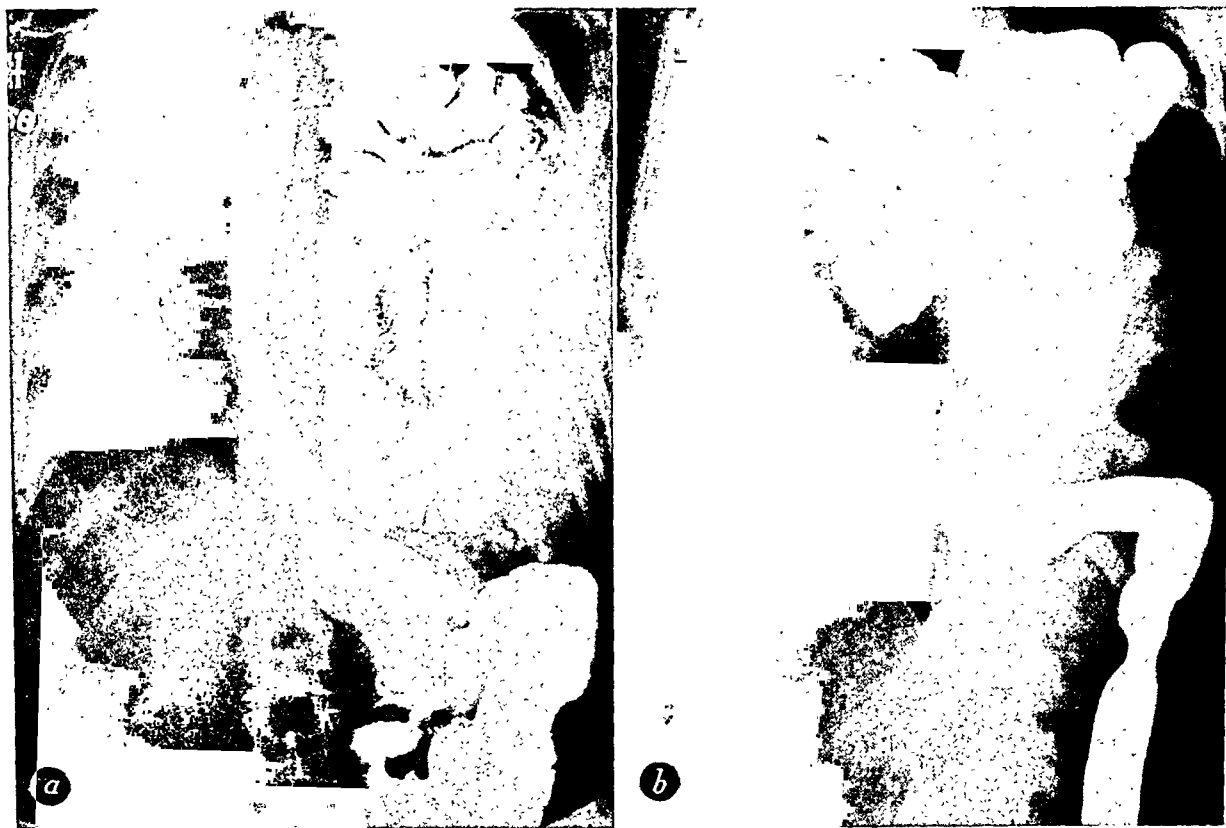


FIG. 12. Pleuroperitoneal hernia in the case of a twenty-nine year old woman. *a*. Large amount of small bowel above the diaphragm. At operation it was found that the pleuroperitoneal membrane had completely failed to develop with a resultant defect in the posterior segment of the diaphragm. The stomach is in normal position below the diaphragm. *b*. Oblique view; transverse colon, ascending colon and numerous loops of small intestine above the left diaphragm.

encountered are colon, small bowel and sometimes spleen and stomach. Pleuroperitoneal hernias may occur on either the right or the left side.

Roentgenograms of the thorax are important in diagnosis. These hernias are located posteriorly. Shadows in which the continuity is incomplete above the diaphragm may very possibly be pleuroperitoneal hernias. Frequently a pleuroperitoneal hernia will have the appearance of an abscess or cysts of the lower lobes of the lungs. Bizarre shadows in the roentgeno-

termine the contents of the hernia and its type and location (Figs. 11 and 12). Diaphragmatic motion may be affected on the side of the hernia and the diaphragm should be carefully examined by means of roentgenoscopy in order to aid in both diagnosis and differentiation.

#### X. CONGENITAL DEFECTS IN THE DIAPHRAGM

This group of hernias includes all congenital hernias which are not included under the esophageal hiatal group, the foramen of Bochdalek and the foramen of

Morgagni hernias (Fig. 13). Failure of development with defect in the diaphragm has been reported in nearly every segment of the diaphragm. Congenital defects, however, seem to be more prevalent on the left side than on the right.<sup>49</sup>

genologic examination of the thorax. Abnormal shadows, especially in the left region of the diaphragm, must be thoroughly investigated before they are dismissed from consideration. Lateral roentgenograms of the thorax may be useful here



FIG. 13. *a.* Stomach and a portion of small bowel of a forty-four year old woman who had congenital absence of the posterior half of the diaphragm on the left. The hernia contained stomach, colon and small bowel. *b.* Lateral view of the stomach.

In many of these cases the patients are newborn infants with developmental defects in the diaphragm. Rawes,<sup>51</sup> Swope,<sup>61</sup> Kerr and Steinberg,<sup>39</sup> Bradley, Zulich and McKee,<sup>8</sup> and Keith<sup>38</sup> have reported cases in which congenital defects in the diaphragm were present in infants and children.

The roentgenologist again must be on the alert for these lesions in the routine roent-

again. The observation of any suspicious shadow in the diaphragmatic region should indicate further examination by means of opaque mediums and roentgenoscopy to differentiate the nature of the lesion. These hernias may contain stomach, colon, small bowel and spleen and adequate roentgenoscopic investigation of these involved viscera must be carried out.

In newborn infants it is especially im-

portant to consider the possibility of diaphragmatic hernia. A routine roentgenogram of the thorax might lead to a diagnosis which would save the infant's life by presenting evidence of hernia which would warrant further investigation by means of opaque mediums which could prove the diagnosis. This is an especially difficult group of patients to handle. However, the frequency with which roentgenograms of the thorax are obtained in infants who have cardiac or respiratory embarrassment is increasing and it is very probable that the diagnosis can be made much more often. Carter and Harrington in discussing an article by Harrington<sup>26</sup> have pointed out that too many of these infants die without benefit of treatment that could save their lives.

#### XI. CONGENITAL ABSENCE OF THE HEMIDIAPHRAGM

Congenital absence of the left half of the

diaphragm was described by Harris and Clayton-Greene<sup>28</sup> in 1912. In their case the patient was a woman thirty-one years old. A diagnosis of diaphragmatic hernia was made by means of opaque bismuth mediums and roentgenoscopic examinations. The patient was operated on and found to have congenital absence of the left hemidiaphragm. This illustrates why it is important that congenital absence of the diaphragm be considered in the diagnosis of diaphragmatic hernia. Jenkinson<sup>36</sup> has also emphasized this point in an article on this subject. LeWald<sup>41</sup> stated that there are probably a considerable number of cases of complete absence of the left half of the diaphragm which have been recorded as diaphragmatic hernia.

In many of the cases of congenital absence of the hemidiaphragm the patients die in infancy but a number of these patients live to adult life. Jenkinson<sup>36</sup> in 1931 reported that there were 14 cases in the



FIG. 14. Posttraumatic diaphragmatic hernia in the case of a thirty-four year old man. *a*. Stomach and colon in left side of the thorax. Three years before admission the patient had been in an automobile accident, in which he was doubled up under a car. At operation the diaphragm was found to be torn from one-half of the thoracic wall posteriorly, and stomach, colon, spleen, small bowel and left kidney were found within the left side of the thorax. *b*. Lateral view to show the stomach.



FIG. 15. Posttraumatic diaphragmatic hernia in the case of a twenty-five year old man. *a.* Stomach and colon above the left side of the diaphragm. At operation patient was found to have stomach, transverse colon, omentum, spleen and left lobe of liver in the left side of the thorax. A large laceration of the left side of the diaphragm which was located at the junction of the posterior and middle thirds and which involved two-thirds of the diaphragm was found. One year before admission the patient had received a crushing injury to the thorax in an automobile accident. *b.* Lateral view of the thorax; colon above the diaphragm.

literature in which patients had lived to adult age.

The appearance of the roentgenogram of the thorax may closely simulate that of eventration. Lateral roentgenograms of the thorax may be of some value in determining the location of the diaphragm but it is often extremely difficult to be sure of its location. If it is very thin or very high it can still be readily distinguished in cases of eventration. A lateral view of the thorax to include the diaphragm which shows only one leaf of the diaphragm with no evidence of eventration should suggest congenital absence of the diaphragm or diaphragmatic hernia. Complete absence of the diaphragm will permit bowel and viscera to be present in the thoracic cavity. It is also necessary to differentiate complete absence of the diaphragm from diaphragmatic hernia. In uncomplicated cases this

would not be difficult. However, if the hernia has been present for some time and if it is relatively fixed in position with a large amount of bowel in the thorax obscuring the diaphragmatic structure, it may be extremely difficult to differentiate these two conditions accurately.

Roentgenoscopic examination of the diaphragm is extremely important since shadows which simulate the appearance of the diaphragm in cases of congenital absence may be determined by careful roentgenoscopic examination. Jenkinson<sup>36</sup> has stated that occasionally the stomach may simulate the diaphragm but that roentgenoscopic examination of its movements will serve to differentiate it from the diaphragm.

Fortunately, congenital absence of the diaphragm is extremely rare. It should, however, be ruled out in cases of large diaphragmatic hernia since there is no method



FIG. 16. Inflammatory necrosis of the diaphragm with diaphragmatic hernia in the case of a fifteen year old girl who had a ruptured appendix with generalized peritonitis followed by empyema. Roentgenograms of the stomach show stomach and colon above the diaphragm. At operation inflammatory necrosis of the diaphragm was noted with three large openings in the diaphragm which measured from 4 to 9 cm. in diameter, and through which the abdominal viscera had herniated.

by which the surgeon can repair congenital absence of the diaphragm.

## XII. POSTTRAUMATIC HERNIA

Posttraumatic diaphragmatic hernias may be divided into two groups. The first of these is the traumatic type following wounding by knife or gunshot, a crushing injury or a violent forward flexion of the body. Wounds and injuries due to automobile accidents may replace gunshot and knife wounds as a prime source of traumatic diaphragmatic hernia (Fig. 14). Harrington<sup>26</sup> has stated that the post-

traumatic type of hernia may be due either to direct or to indirect injury to the diaphragm. In cases of indirect injury the hernia may occur at any point, including the points of embryologic fusion, but the most common sites are the dome and the posterior half of the left hemidiaphragm. Among the types of indirect injury is the violent forward flexion of the body which acts like crushing a rubber balloon in the fist (Fig. 15). The second type of posttraumatic hernia is the erosion which may develop in the diaphragm following inflammatory necrosis of a segment of the diaphragm (Fig. 16). This may occur in conjunction with subdiaphragmatic abscesses following a surgical procedure within the abdominal cavity.

Traumatic hernias of the diaphragm may occur anywhere in the diaphragm. In the direct type the point of injury determines the location of the hernia. Symptoms usually develop very soon after the injury and the onset of symptoms is almost always directly related to the injury although this may not be always true. In the injury all three layers of the diaphragm are involved. When the viscera protrude through this opening there is no hernial sac, unless there is indirect injury.

The roentgenograms of the thorax should be the starting point in investigation of this type of hernia. We wish to emphasize the importance of the routine roentgenographic examination of the thorax. Any suspicious shadow within the bases of the pleural cavity must be examined with the possibility of diaphragmatic hernia in mind. The clinician can be of great help also if there is obtained a history of injury with subsequent development of symptoms. The lateral view of the thorax may serve to clarify the suspicion or it may not. In any event the definitive diagnosis depends on the examination of the alimentary canal by the use of opaque mediums. Sometimes if the contents of the hernia consist of solid viscera or omentum the diagnosis may be very difficult to obtain. Roentgenoscopy may be of some value, however, and a close and

careful examination of both sides of the diaphragm may lead the examiner to strong suggestive evidence of the diagnosis.

If posttraumatic diaphragmatic hernia is suspected, examination of the stomach, small bowel and colon should be carried out in addition to stereoscopic and lateral views of the thorax.

### XIII. EVENTRATION

Eventration of the diaphragm is important because of the necessity of differentiating this condition from diaphragmatic hernia. It is unfortunate that the term "eventration" has been applied to this condition, since it is a misnomer. As Giffin<sup>21</sup> has pointed out, it is not a good term. Surgically it means that a large portion of the abdominal viscera is outside the peritoneal cavity. Obviously this does not occur in eventration. Bayne-Jones<sup>4</sup> has stated that among diaphragmatic lesions, none has had more names attached to it than eventration. If a term which was more accurate could be universally adopted it would simplify matters but since the term "eventration" has been used to describe this condition for many years, it would probably be easier to attempt to establish a definition of eventration which would describe the condition to which common usage has applied the term.

Various definitions have been suggested. One definition suggested is "a thinning out and fatty degeneration of the muscular fibers of the diaphragm and bulging upward of the same to the level of the second or third rib." Sailer and Rhein<sup>59</sup> proposed that eventration be defined as "an abnormally high position of the diaphragm with dislocation upward of the abdominal viscera, especially stomach with hypoplasia of the left lung and dislocation of the heart to the right." In any definition there are two necessary factors: (1) that the hemidiaphragm be elevated to an abnormally high position and (2) that the hemidiaphragm be markedly thinned out.

These two things being present, one could define eventration as a markedly

thinned out and highly elevated diaphragm.

The causation of eventration has not been adequately explained. Several hypotheses have been advanced, none of which have gained wide acceptance and none of which seem to explain satisfactorily why eventration occurs.

The pathologic anatomy of eventration has been studied a number of times. The diaphragm on the affected side is described as a thin membrane covered above by pleura and below by peritoneum. Between these membranes, which are normal in appearance, is a thin sheet of fibrous tissue. Within the layer of fibrous tissue a few occasional strands of muscle may be seen. In some cases the muscle strands were found to be replaced by fat cells. There was sometimes a fringe of normal muscle around the costal attachments of the diaphragm, which disappeared as the dome was reached. Examination of the phrenic nerves revealed that they were slightly smaller on the affected side than on the opposite side but apparently normal in every other respect. Necropsy has shown that while the diaphragm may be markedly elevated the lung is not compressed. This is a strong argument in favor of a congenital defect in development of the lung on the affected side or a congenital defect in development of the diaphragm.

The diagnosis of eventration is not an easy one to make. Frequently the diagnosis is presumed when the examiner has satisfied himself that there is no diaphragmatic hernia present. The classic description of eventration is of a markedly elevated diaphragm on the affected side with a high arched smooth contour. The diaphragm may be very highly placed or it may not be. Varying degrees of elevation from the ninth rib in the posterior axillary line to the fifth rib in the posterior axillary line were seen in our series of cases of eventration. The thinning of the dome of the diaphragm with the resultant high arch is characteristic of eventration but the degree of arching is variable and since there is considerable

variation of the shape of the diaphragm in human beings, the high arching curve of the diaphragm is not always seen in cases of eventration. Because of individual variation and because of possible inflammatory reaction as well as a variable amount of muscle function in the small fringe of muscle still remaining in the diaphragm, the contour of the diaphragm in cases of eventration is not always smooth and regular. It may at times be quite irregular.

The motion of the diaphragm in cases of eventration may be one of three types: (1) it may be normal but considerably decreased; (2) it may be paradoxical; (3) there may be no motion at all. If there is any function in the fringe of muscle fibers remaining in the diaphragm a small amount of normal motion may be produced. If there is no function remaining and the diaphragm is free, paradoxical motion will result. If there are adhesions causing fixation of the diaphragm, then it will be immobile.

There is no specific age group. In fact if one accepts the hypothesis that eventration is probably a congenital lesion, then it may be encountered at any time during life. In most of our cases the age of the patients ranged between forty and sixty years.

Apparently eventration is more frequent among men than among women, in a ratio of about 3:1 (27 per cent in women, 73 per cent in men). This is in agreement with other presentations on the subject.<sup>35</sup>

Eventration is associated with some displacement of the cardiac shadow to the right. This varies in degree but is present in more than 50 per cent of the cases of eventration. We did not find any eventration associated with dextrocardia in our series of cases.

We reviewed 40 cases in which the roentgenographic diagnosis of eventration had been made or suspected. Of these 40 cases we felt that 26 were examples of eventration. There is no specific roentgenographic or roentgenoscopic criterion for the diagnosis of eventration nor does it appear that there ever will be. The diagnosis is not always entirely satisfactory. Analysis of the history and careful examination, both

roentgenoscopic and roentgenologic, should give enough evidence to reach somewhere near the truth.

However, more important than the diagnosis of eventration, which may be of academic interest only, is the differentiation between diaphragmatic hernia and eventration. This differentiation is extremely important and usually quite difficult. Many suggestions have been made for the differentiation of eventration from diaphragmatic hernia. Their very multiplicity should suggest that there is no definite specific method by which it is possible to make this differentiation. However, if all of these methods be employed it is reasonable to expect that a positive diagnosis may be aided by one or more of these suggestions. Their limitations should be borne in mind, and it would be unwise to depend entirely on a single method of differentiation.

As was stated before, in the roentgenoscopic examination of patients who have eventration the diaphragm may be immobile, may demonstrate paradoxical motion or may appear to move normally. Various authors have suggested the use of these facts as an aid in differentiation of this condition from diaphragmatic hernia. Unfortunately all three states of the diaphragm may be found in cases of diaphragmatic hernia as well. Thus the motion or lack of motion fails to help. Theoretically, if there were no adhesions, the diaphragm on the affected side in cases of eventration should show some paradoxical movement and a much greater excursion than the normal side. Except in those cases with a small fringe of muscle present it cannot contract since there is no muscle to produce movement and if there is muscular movement, then we are not dealing with true eventration. If there were nothing to complicate the situation such as adhesions and fixation of the diaphragm, then the diaphragm in cases of eventration should show paradoxical movement with considerable excursion, while the diaphragm in cases of hernia moves normally except for a slight paradoxical movement at the

beginning of respiration because it is weakened by the hernia.

The location of pulmonary markings has been suggested also. Obviously, there are no pulmonary markings below the diaphragm in cases of eventration. It is theoretically possible to find them in the region occupied by a hernia.

Another procedure is that suggested by Carman and Fineman.<sup>10</sup> When eventration or diaphragmatic hernia is suspected barium in water is given the patient. The course of the ingested mixture is observed under the roentgenoscope. In cases of diaphragmatic hernia the fluid will assume a higher level than the cardiac orifice of the stomach while in cases of eventration it never goes above the cardiac orifice.

Overholt<sup>48</sup> has listed various tests used in differentiation. Among these is a physical sign involving the movements of the costal margins. Normally the outward excursions of the costal margins are limited by the pull of the diaphragm. In cases of eventration this effect is decreased or absent and a more noticeable excursion is allowed on the involved side than on the opposite side. This would be of value in cases of small diaphragmatic hernia and when used in conjunction with other confirmatory evidence. However, it cannot be definite because with a large hernia or defect in the diaphragm it is no longer reliable.

Sante<sup>60</sup> has suggested the use of pneumoperitoneum as an aid in the differential diagnosis of these two conditions. If air is injected into the peritoneal cavity and the patient is placed in the upright position, the air will collect under the diaphragm in cases of eventration whereas if there is a defect in the diaphragm the air will be found in the thoracic cavity. This would also give some indication of whether the apparent hernia is a true hernia or not. If the air is enclosed in a sac in the thorax then one is dealing with a true hernia. If not, it is not a true hernia and these facts are of definite interest to the surgeon. Walton<sup>63</sup> has also suggested the use of pneumoperitoneum as a differential diagnostic aid. This test is a good one if one can get posi-

tive results for hernia. It can be conclusive only if air passes above the diaphragm because, as Reich<sup>52</sup> has suggested, when there are adhesions between the herniated viscera and the diaphragm no definite conclusions can be drawn. Faulkner<sup>18</sup> has suggested another variation of this same idea: the use of pneumothorax as a help in differential diagnosis. If a hernia is present air will pass into the abdominal cavity. Again the same usefulness and the same limitations apply.

Measurement of intragastric pressure has been used by some investigators.<sup>32</sup> The rationale of this method is based on the difference in pressure which obtains in the peritoneal and pleural cavities on respiration and the movement of the diaphragm. If the stomach is in the abdomen the intragastric pressure will rise when the diaphragm descends and fall when the diaphragm ascends. If any part of the stomach is in the thorax the pressure will fall when the diaphragm descends and rise when it ascends. The obvious limitations and the cumbersome apparatus necessary have made this method of little value in differential diagnosis.

Overholt<sup>48</sup> presented a case in which all of these various means of differentiation were tried and no definite conclusions could be reached. Finally the phrenic nerve on the affected side was stimulated by a faradic current. In a case of eventration one would not expect any response, since there is no muscular element to contract unless a small fringe of muscle is present. In a case of diaphragmatic hernia there should be a definite response. In Overholt's case the diaphragm reacted violently. Reich,<sup>52</sup> however, stated that irritation of the phrenic nerve is of no aid in distinguishing between hernia and eventration.

Laparotomy has been done as a means of deciding definitely with what type of lesion one is dealing.

#### XIV. SUMMARY

Diaphragmatic hernia is not an uncommon condition. Examination for diaphragmatic hernia should be a part of every



gastrointestinal examination. It should be considered in the differential diagnosis of lesions near the diaphragm in the roentgenogram of the thorax. The chief obstacle to the diagnosis of diaphragmatic hernia is the neglect to look for it. The responsibility for diagnosis lies with the roentgenologist and his efforts should be commensurate with his responsibility.

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# MYELOGRAPHIC DEMONSTRATION OF AVULSING INJURY OF THE BRACHIAL PLEXUS\*

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THE diagnosis of avulsion of the nerve roots of the brachial plexus, or tear of the roots within the intervertebral foramina, from traction injuries about the neck and shoulder usually presents no difficulty. Such a diagnosis is made in upper brachial plexus injuries on the basis of segmental motor and sensory deficit of the fifth, sixth and sometimes the seventh cervical spinal nerves, including paralysis of the serratus magnus, levator scapulae, and the rhomboids, indicating that the lesion in the nerve roots is medial to the emergence of the nerve supply (long thoracic and dorsal scapular nerves) of these muscles. In lower brachial plexus injuries the diagnosis is made on the basis of segmental sensory and motor deficit of the eighth cervical, first thoracic, and sometimes the seventh cervical spinal nerves, plus a Horner's syndrome. Because such lesions are at present thought to be irreparable and therefore have a poor prognosis, a method of verification of such a diagnosis would be of practical importance.

During the investigation of the cause of pain in the arm and hand of a patient with such a lesion, myelographic evidence was found which seemed to us to confirm the diagnosis of avulsion of the nerve roots. The case is therefore reported in the belief that myelography may be of value in the confirmation of the diagnosis of such lesions.

## CASE REPORT

A soldier, aged twenty-six, while overseas fell from a moving truck on July 7, 1945. Immediately upon striking the ground the soldier became unconscious and he was unable to give details as to exactly how he struck the ground or as to which direction his neck and shoulders were rotated by the blow. He regained consciousness shortly after the injury and noted a

complete paralysis of the left arm from the shoulder down. He was admitted to an overseas hospital where roentgenograms were taken, showing a simple linear fracture of the right fibula, but no fractures in the left arm, the skull, or the cervical spine. The fractured fibula did not require special treatment, and healed satisfactorily. Within a few days after the injury, he noticed gradual improvement in the paralysis of the arm, but continued to have residual paralysis and anesthesia in the forearm and hand. From the time he regained consciousness, this soldier noticed, in addition to the paralysis, a constant aching pain, "like a tooth-ache," along the forearm and into the hand. It had been constant since the day he was injured and kept him awake at night. He stated that the pain radiated along the ulnar side of the forearm, into the little finger, and over the entire dorsum of the hand. It was not aggravated by coughing, sneezing, straining or lifting. Pressure over the brachial plexus did not increase the pain, nor did compression of the cervical spine. The pain was not aggravated by touching the hand, by excitement, loud noise or sudden jars. He found nothing that relieved the pain. Because of the paralysis and pain he was evacuated to the Zone of the Interior, and was admitted to this General Hospital on September 21, 1945, complaining bitterly of the pain in the arm and hand, which he stated had not improved at all since the injury.

Examination showed a well developed, well nourished white male, whose general physical and neurologic examination was negative except with reference to the head and left arm. There was no sensory deficit except in the left arm, and no weakness except in that arm. There was mild Horner's syndrome on the left, manifested by narrowing of the palpebral fissure and slight, but definite, constriction of the left pupil. Examination of the left arm showed no function in the extensor carpi ulnaris, the extensor digitorum communis, abductor pollicis longus, and the extensor pollicis longus and brevis. Further, there was no function in the entire flexor digitorum sublimis and profundus group, in the

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flexor pollicis longus, and in the flexor carpi ulnaris, and no function in any of the intrinsic muscles of the hand. The pronator teres and the flexor carpi radialis were functioning well; the palmaris longus contracted weakly. The brachioradialis and extensor carpi radialis muscles functioned normally. The biceps brachii was weak, and the triceps brachii was very weak, but functioning. Most of the sternal portion of the pectoralis major muscle was not functioning. The latissimus dorsi, rhomboids and levator scapulae, the serratus magnus, and the deltoid were all functioning normally. A careful sensory examination showed areas of anesthesia and hypesthesia as indicated in Figure 1. The skin resistance was abnormally high in the areas indicated in Figure 2. This of course signified complete absence of sweating in these areas.

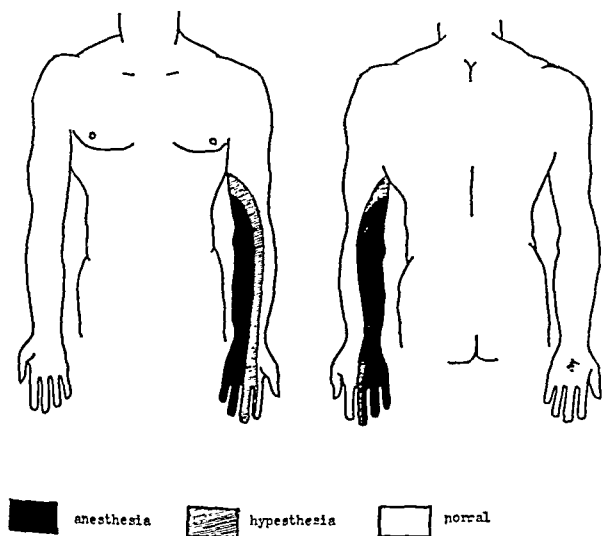


FIG. 1. Sensory examination, showing a sensory deficit in areas supplied by the seventh and eighth cervical and first thoracic nerve roots.

Roentgen examination of the chest, shoulder, and cervical spine failed to reveal any definite abnormalities. Routine laboratory examinations of the blood and urine and the serology were normal.

It was the impression, from the motor and sensory findings, that this man had an avulsion of the seventh and eighth cervical and first thoracic roots of the brachial plexus, and therefore that no neurosurgical procedures to repair the nerves would be of value. The pain presented a difficult diagnostic problem. It was felt that it had none of the stigmata of causalgia, nor did it have any of the features suggesting a herniated nucleus pulposus or scalenus anticus syndrome. There was no cervical rib demon-

strated by roentgen examination, and there were no abnormalities noted in the first rib. However, procaine block of the left stellate ganglion was carried out on two occasions with complete relief of pain for fifteen to thirty min-

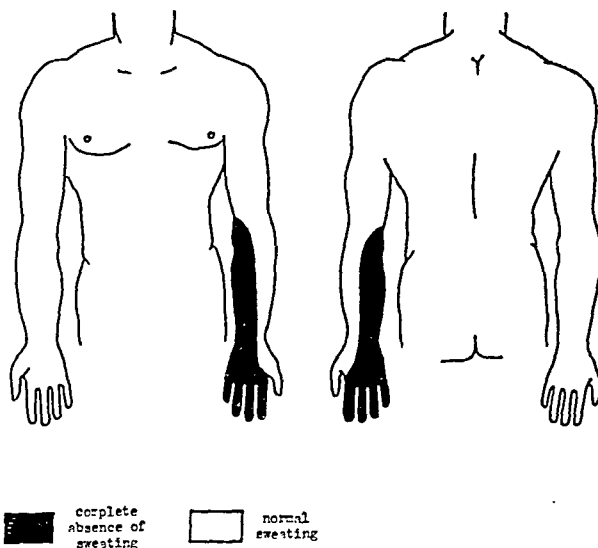


FIG. 2. Dermometer examination, indicating area of de-sweating produced by injury (test done prior to sympathectomy).

utes. Still, it was not felt with any certainty that sympathectomy would offer relief.

A cervical myelogram was made in order to rule out the presence of a herniated nucleus pulposus in the cervical region. This failed to reveal any evidence of a cervical disc. However, it gave a very striking demonstration of what are believed to be traumatic meningoceles at the level of the seventh and eighth cervical and first thoracic nerve roots. The pantopaque appeared to enter the upper dorsal and cervical region normally. However, it was immediately noted that all the nerve sheaths of the left were absent and a linear filling defect was present (Fig. 3). The linear defect measured approximately 3 to 4 mm. in width and extended from the level of the third cervical vertebra down to and including the first dorsal vertebra. The left lateral border of the opaque column was straight and smooth. The cervical pulsations were normal. After several minutes of observation a small drop of the opaque material was seen to detach itself from the main column and migrate laterally into a pouch-like structure in the region of the left intervertebral foramen between the sixth and seventh cervical vertebrae. Immediately thereafter, other drops of the opaque material were detached and also migrated laterally in this region, and in the region

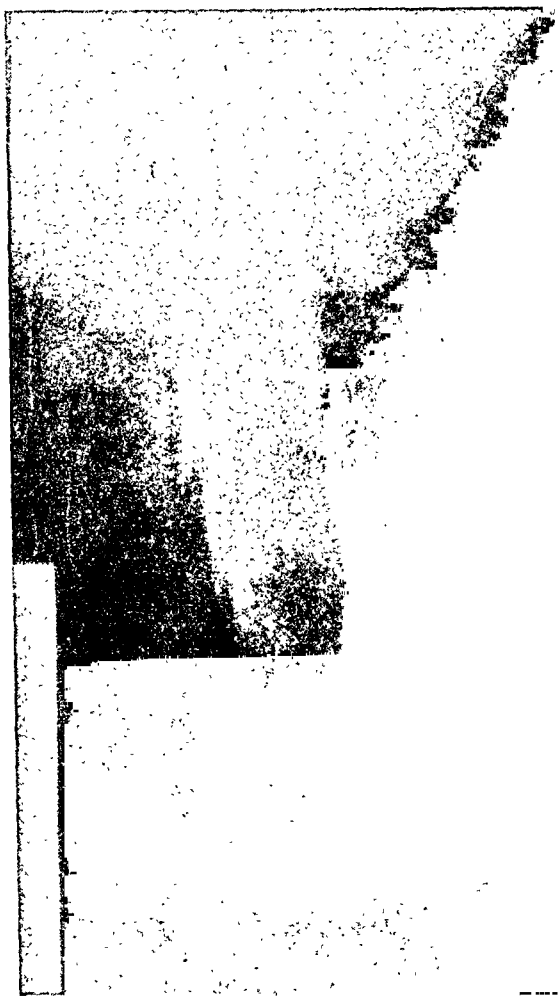


FIG. 3. Cervical myelogram showing opaque column in the cervical region.

of the intervertebral foramina between the seventh cervical and first dorsal, and between the first and second dorsal vertebrae. These also collected in a pouch or diverticulum-like structure. The droplets seemed to be forced laterally by the cervical pulsation. At no time was a connection seen between the lateral collections and the main opaque column. They were always separated by the linear defect. The pouches were completely filled at the end of approximately ten minutes (Fig. 4). The lateral collections in no way resembled lateral extension of the opaque material within a nerve sheath. When the patient was placed in the upright position the main opaque column moved out of the cervical region in a normal manner, but the lateral collections remained (Fig. 5). Films of the cervical region on the following day showed no pantopaque in the cervical region either in the normal subarachnoid space or in the out-pouchings. The right side appeared normal.

Because of the severity of the pain and the

relief obtained from procaine block of the stellate ganglion, it was felt that this patient should be offered a dorsal sympathectomy, despite the fact that his pain syndrome was *not* causalgia and despite our lack of assurance that the operation would relieve the pain. Laminectomy was not considered advisable, first, because the lesions in the nerve roots were felt to be irreparable; and, second, because it was not believed that the meningoceles were causing any pressure on the remains of the nerve roots. After explanation of the entire situation to the patient, he chose to have the operation. Therefore, a dorsal sympathectomy (modified Smithwick) was performed. The postoperative course was uneventful except for the presence of a pneumothorax secondary to air having entered the pleural space at surgery. However, the lung reexpanded satisfactorily and his postoperative condition was good at all times. Six weeks after sympathectomy the patient stated that his pain had not been significantly improved by the



FIG. 4. Cervical myelogram showing lateral collections of pantopaque.

operation. It was not now constant, but occurred on frequent occasions and, when present, was as severe as it was prior to surgery. The cause of his pain is still undetermined. There has been no change in the motor and sensory examination since admission to this hospital six months ago.

#### COMMENT

The motor and sensory paralyses presented by this patient seem entirely consistent with the diagnosis of avulsion of the seventh and eighth cervical and first thoracic nerve roots of the brachial plexus. A portion of the preganglionic sympathetic fibers to the eye were interrupted by this avulsion, since they emerge at least in part from the spinal cord via the first thoracic nerve root. Since the preganglionic fibers to the arm emerge from the cord through the second thoracic nerve root and those situated more caudally, probably none of these were interrupted in this case. The skin resistance findings in the left arm are probably the result of tearing of the seventh and eighth cervical and first thoracic nerves and the grey rami coming to them from the ganglionated sympathetic chain. This then is a postganglionic interruption.

It must be pointed out that the myelographic findings are probably those of a rupture of the meninges in the region of the seventh and eighth cervical and first thoracic nerve roots, thus allowing the opaque material employed in the myelogram to escape from the subarachnoid space in these areas. The material thus presumably flowed into three spaces, which were occupied by the seventh and eighth cervical and first thoracic nerve roots prior to their avulsion. The term "traumatic meningocele" has been employed here as one of convenience, although of course we have no way of knowing that these out-pouchings are actually lined by the meninges. Although we have not visualized these areas surgically in this patient and thus have not established with certainty this diagnosis, the striking myelographic findings, coupled with the clear neurological findings, make the above interpretation seem very probable.



FIG. 5. Cervical myelogram showing lateral collections remaining after the column of pantopaque had been removed from the cervical region.

The practical importance of the demonstration of such an avulsion is obvious. Without it, one would probably be forced to wait a period of twelve to eighteen months before proceeding with reconstructive surgery of the wrist and hand—for only by waiting would one know with certainty how much return of function might ensue. With this demonstration, however, it seems highly probable that there will be no retrun of function in the paralyzed muscles innervated by the seventh and eighth cervical and first thoracic nerves. Reconstructive surgery will thus be undertaken promptly in order to give the patient, so far as possible, a useful hand.

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# PHYSIOLOGICAL STASIS: A CAUSE OF CHOLECYSTOGRAPHIC ERROR\*

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SINCE the advent of cholecystography in 1924 the diagnosis of gallbladder disease has become extremely simple and accurate. Yet false cholecystographic findings occasionally lead to unwarranted diagnoses and unnecessary surgery. This paper will discuss an important but frequently neglected cause of cholecystographic error—physiological stasis of the gallbladder.

Non-visualization of a normal gallbladder is probably more frequent than most papers concede. Statistical evaluation based upon operative confirmation may be misleading because factors unconcerned with cholecystography enter into the selection of patients for surgery; most patients with an erroneous roentgen diagnosis of poorly functioning gallbladder will not be suitable for surgical treatment.

These errors should not be dismissed with the statement that diagnosis must depend also on clinical findings; all accept the

dictum that cholecystography is not a test for cholecystectomy. The error is equally real whether or not laparotomy is performed, and a grave injustice is done when a patient is placed on an unnecessary medical regimen. The real problem is to eliminate such errors or to recognize situations in which the examination is unreliable.

## BILIARY PHYSIOLOGY

Cholecystography is actually a roentgen demonstration of gallbladder physiology; when pathologic physiology is demonstrated the deduction follows that pathologic anatomy is present.

When bile is excreted by the liver into the hepatic and common duct, sustained contraction of the sphincter of Oddi prevents the bile from passing into the duodenum, but it can pass through the cystic duct into the gallbladder, where fluid is rapidly absorbed and the bile is concentrated. Thus the gallbladder can contain the entire liver output for a twenty-four hour period, at the end of which time it is filled with a thick concentrate of bile salts, pigment, and mucin. Upon proper stimulation the gallbladder is capable of self

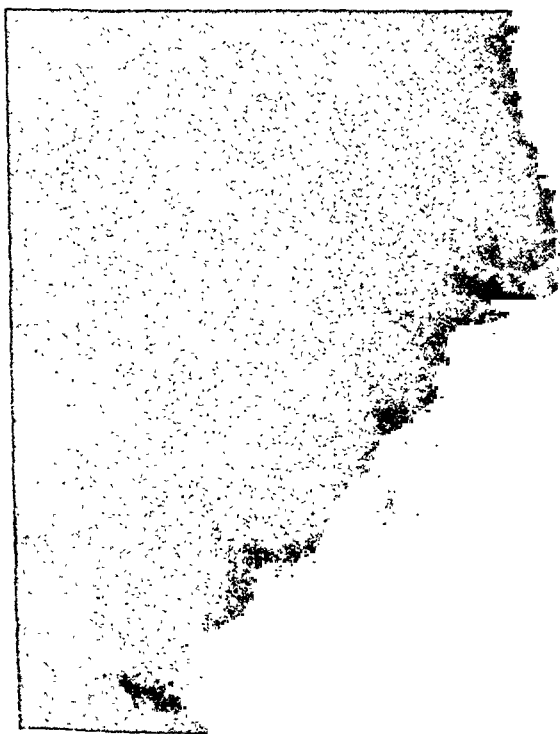


FIG. 1. Very faint gallbladder shadow eight hours after intravenous administration of sodium tetraiodophenolphthalein. *Case History.* A white male, aged thirty-four, had been acutely ill for several days with severe right upper quadrant pain and vomiting. There was fever and leukocytosis and the attending surgeon's diagnosis was acute cholecystitis. Oral cholecystography revealed no concentration of the dye; re-examination by the intravenous method produced faint gallbladder shadows, definitely not normal. Laparotomy disclosed a grossly normal gallbladder and a perforating gastric ulcer. The greatly decreased gallbladder function demonstrated by intravenous cholecystography can be explained only on the basis of physiological stasis secondary to vomiting and lack of food prior to examination.

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FIG. 2. *A*, no gallbladder shadow is visible after intravenous administration of the dye. *B*, fairly good gallbladder shadow, oral dye, after two days' fat feeding. *Case History.* A white male, aged fifty-four,

hospitalized because of severe right upper quadrant pain of one day's duration and nausea and vomiting of three days' duration. The patient had complained of right upper quadrant pain and vague gastrointestinal symptoms for one year, and had been on a fat free diet; he had not had previous roentgen examination. At this time the family physician's diagnosis was acute cholecystitis. Cholecystography by both oral and intravenous methods revealed no definite gallbladder shadow, but in view of the above dietary history re-examination after fat feeding was recommended. Two days later oral cholecystography revealed a gallbladder of fairly good density. Gastrointestinal study the following day disclosed a duodenal ulcer with evidence of localized perforation, a diagnosis which was later confirmed at laparotomy. The original non-function of the gallbladder was probably due to physiological stasis. This contention is supported by the normal response after a short period on fat diet, and at laparotomy a grossly normal gallbladder was found.

evacuation, fat being the only food which will bring about this action.

Certain radiopaque substances are excreted in the bile; roentgen visualization of the gallbladder depends upon subsequent concentration of the dye-laden bile in that organ. Now, if a patient has been limited to a completely fat free diet or has been unable to retain any food, the gallbladder may not have emptied for several days. The bile will be thick and concentrated. When cholecystography is attempted in the presence of such physiological stasis, fresh dye-laden bile is unable to enter the gallbladder; it does not function and it does not visualize, just as though patho-

logic changes were present. In other cases partial concentration of the dye results in a faint shadow.

#### MATERIAL

The cases reported were selected from a series of 500 consecutive cholecystograms using priodax, the commercial name for beta-(4-hydroxy-3,5-diiodophenyl)-alpha-phenyl-propionic acid. The first 150 patients in the series included 46 who were also examined by means of intravenous sodium tetraiodophenolphthalein, as a check when the gallbladder was not adequately visualized by the oral method. That series has been previously reported<sup>1</sup>



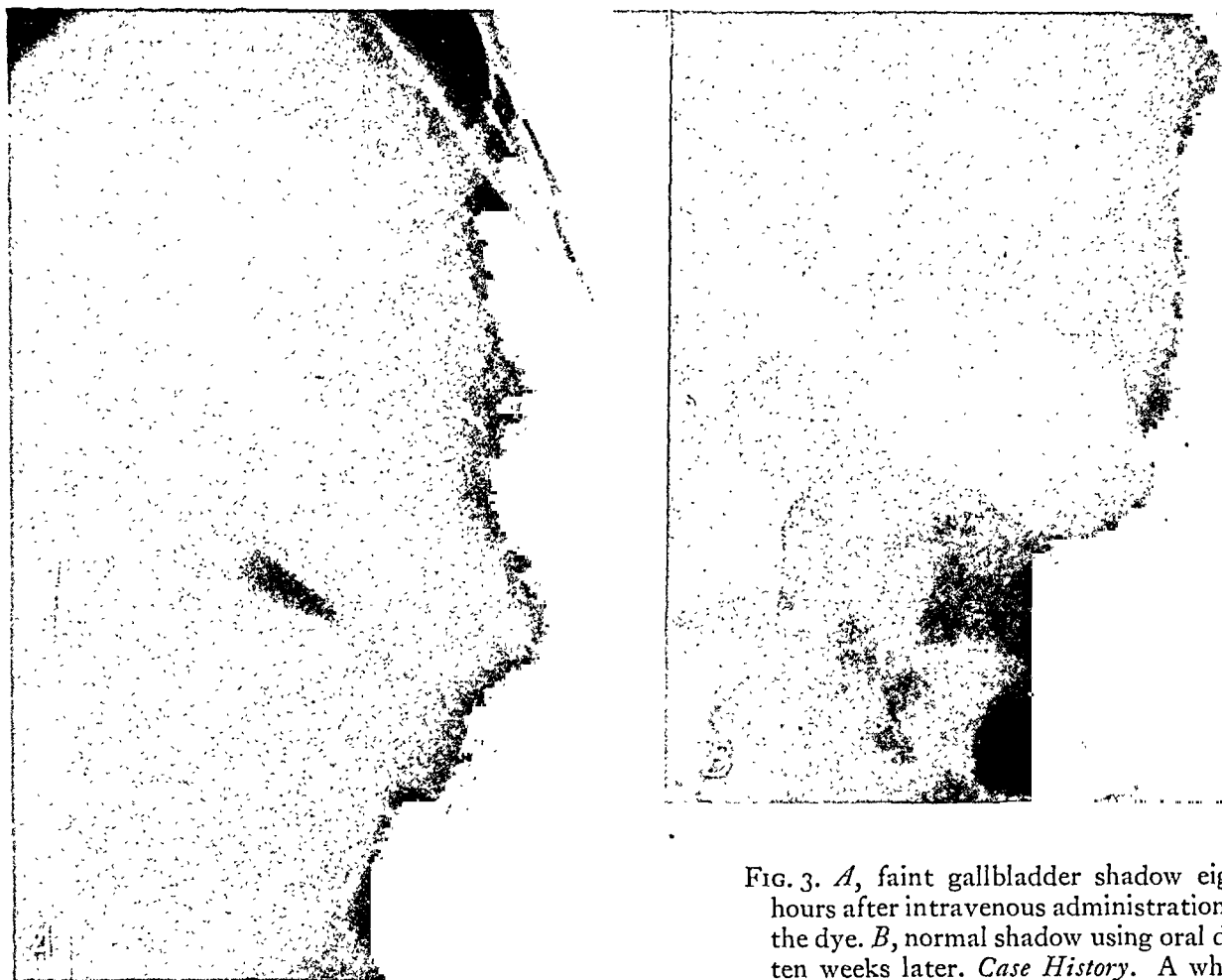


FIG. 3. *A*, faint gallbladder shadow eight hours after intravenous administration of the dye. *B*, normal shadow using oral dye ten weeks later. *Case History*. A white male, aged fifty-six, complained of inter-

mittent epigastric pain and vomiting for four days prior to cholecystography. Examination with priodax disclosed no definite gallbladder shadow, and re-examination by the intravenous method revealed a very faint shadow. It was suggested that the decreased function could be due to physiological stasis rather than gallbladder pathology. Gastrointestinal study with a small quantity of barium revealed pronounced gastric residue which precluded satisfactory examination of the stomach. There was small intestinal distention and hypomotility. Barium enema revealed a sharply localized constriction of the sigmoid colon, not typical of carcinoma. Laparotomy disclosed this was due to adhesions, which were released, and the patient made an uneventful recovery. Re-examination of the gallbladder at a later date revealed normal concentration of the dye. It is probable that the non-function as determined by intravenous cholecystography was due to physiological stasis.

with particular reference to and discussion of discrepancies in the results. It was apparent that discrepancies were due to physiological stasis and that this is a more significant factor in oral than in intravenous cholecystography. However, cases reported here will show that the intravenous method is also subject to this limitation (there is no duplication of cases reported in the two papers).

#### TECHNIQUE

Meticulous roentgen technique is imperative. Of utmost importance is equipment

capable of short exposures, preferably using the rotating anode tube and the fast Potter-Bucky diaphragm.

The evening before examination six 0.5 gm. priodax tablets are swallowed whole during the course of a completely fat free evening meal. The patient may have water until bedtime but is allowed nothing by mouth after midnight. He reports to the roentgen department the next morning and at fifteen hours the first films are exposed. The roentgenologist sees the films, interviews the patient, and outlines subsequent procedures. Cholecystograms in oblique or

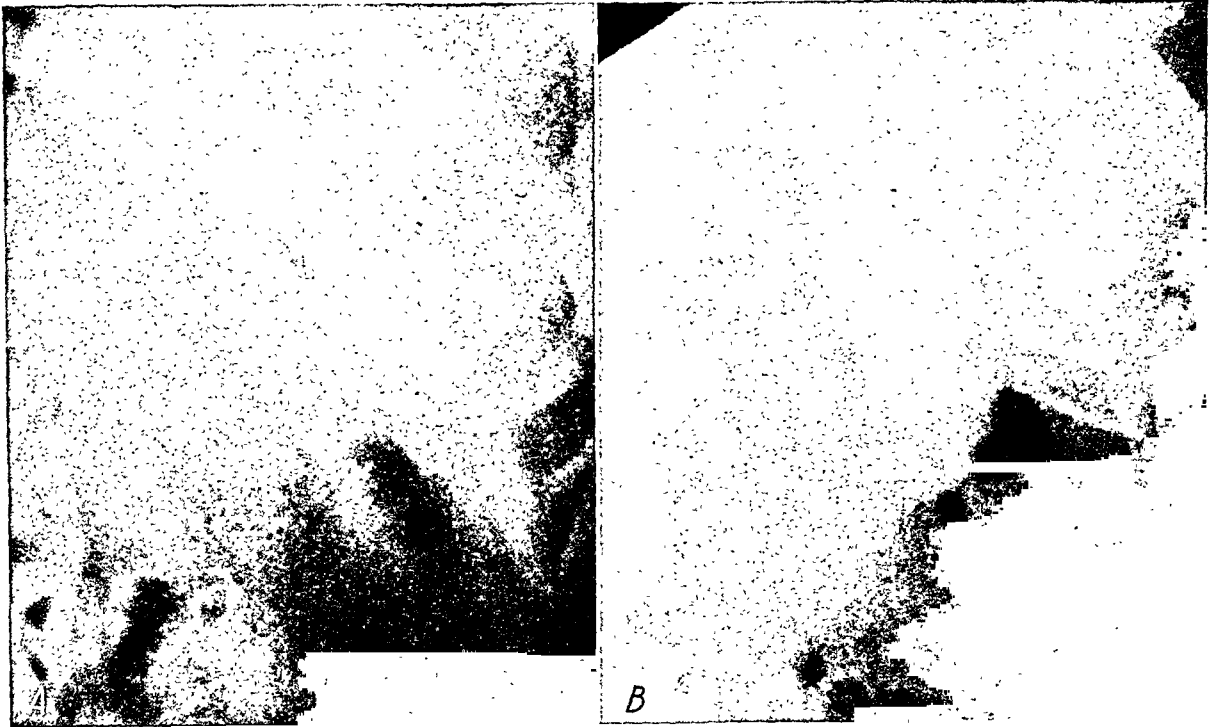


FIG. 4. *A*, oral cholecystogram revealing poor concentration. *B*, normal concentration four days later. *Case History*. This white female, aged forty-one, complained of right upper quadrant pain of five years' duration. She had been on a fat free diet for many months. Oral cholecystography revealed very faint shadows and poor concentration of the dye, and in association with the history this might have been considered adequate evidence of cholecystitis. However, after five days on a high fat diet, re-examination resulted in a gallbladder shadow of normal density.

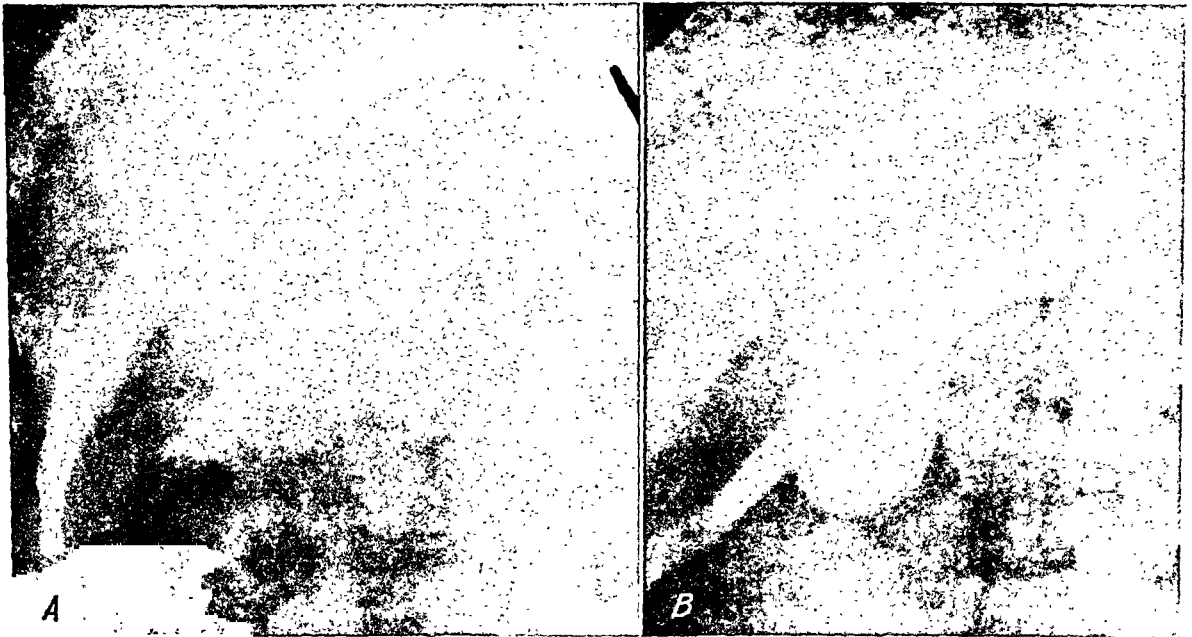


FIG. 5. *A*, priodax cholecystogram showing very faint gallbladder shadow. *B*, satisfactory concentration three weeks later. *Case History*. A white female, aged thirty-nine, complained of upper abdominal pain of several days' duration (not typical of cholecystitis), and nausea and vomiting. The oral dye was retained without vomiting, but the gallbladder shadow was extremely faint. Re-examination after three weeks on a high fat diet resulted in fairly good concentration of the dye.

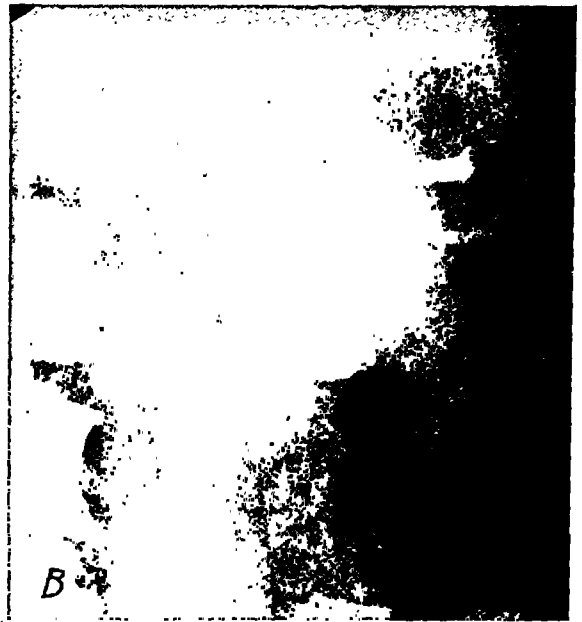
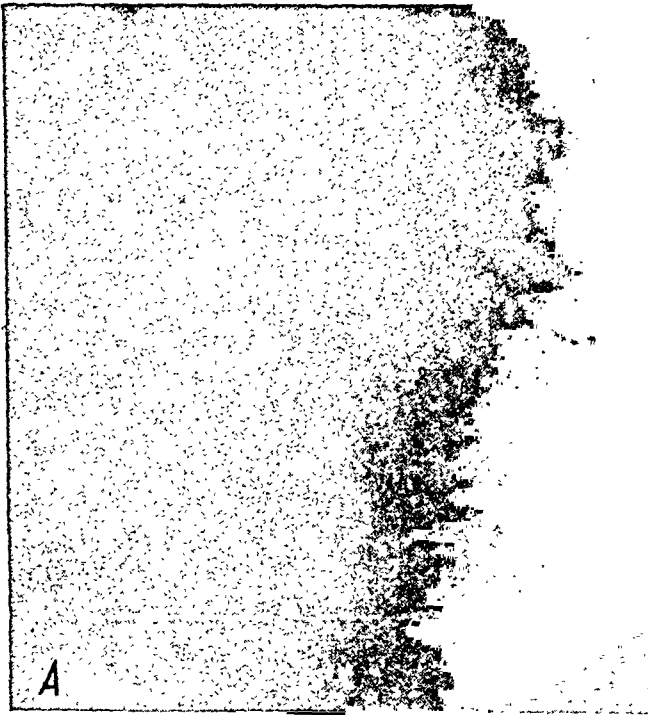


FIG. 6. *A*, oral cholecystogram, no gallbladder shadow. *B*, oral cholecystogram six days later showing normal concentration. *Case*

*History.* A white female, aged forty-eight, was examined with priodax following two weeks of generalized abdominal pain, nausea, and vomiting, during which time she had eaten very little. No definite gallbladder shadow could be demonstrated. After six days on a high fat diet re-examination revealed a normal gallbladder shadow.

erect positions, or with compression, or at a later hour may be requested. Since the patient is fasting, a barium meal study may be started without delay if further gallbladder examination is not necessary.

#### DISCUSSION

Papers on cholecystography often enumerate certain conditions other than cholecystitis which may cause non-visualization, but rarely is physiological stasis included. Nevertheless this is not a new concept. Curl's<sup>2,3</sup> studies on over 400 normal subjects offer convincing evidence that the diet prior to examination does influence the response to the dye. He concluded that patients on a fat free or low fat diet may have a gallbladder so distended with thick concentrated bile it is unable to admit fresh dye-laden bile, hence will not be visualized on roentgen examination.

Other authors who have given the problem some consideration include Whitaker,<sup>7</sup> who reported finding a normal gallbladder filled with thick concentrated bile after non-visualization by the intravenous method. Robinson<sup>6</sup> recommended the routine administration of a fat meal three

hours prior to ingestion of the dye. Jenkinson<sup>5</sup> advocated that all patients with non-visualization be re-examined after a month during which time a diet rich in fats should be given. Feldman<sup>4</sup> suggested a diet consisting of eggs, milk, cream, and other foods should precede the administration of dye, in order to prevent excessive concentration of bile which may result in faint shadows or non-filling.

The case histories in this report offer further evidence that diet prior to cholecystography has a profound influence. It should be noted that in the first 3 cases both oral priodax and intravenous tetraiodophenolphthalein were used, so there should be no question as to absorption of the dye.

Physiological stasis should always be considered when evaluating non-visualization of the gallbladder, and it is of even more importance when the shadows are faint. When there is history of fat free diet or vomiting and limited food intake prior to examination, a faint shadow is of indeterminate significance, and non-visualization must be viewed with suspicion.

Procedures which will eliminate or re-

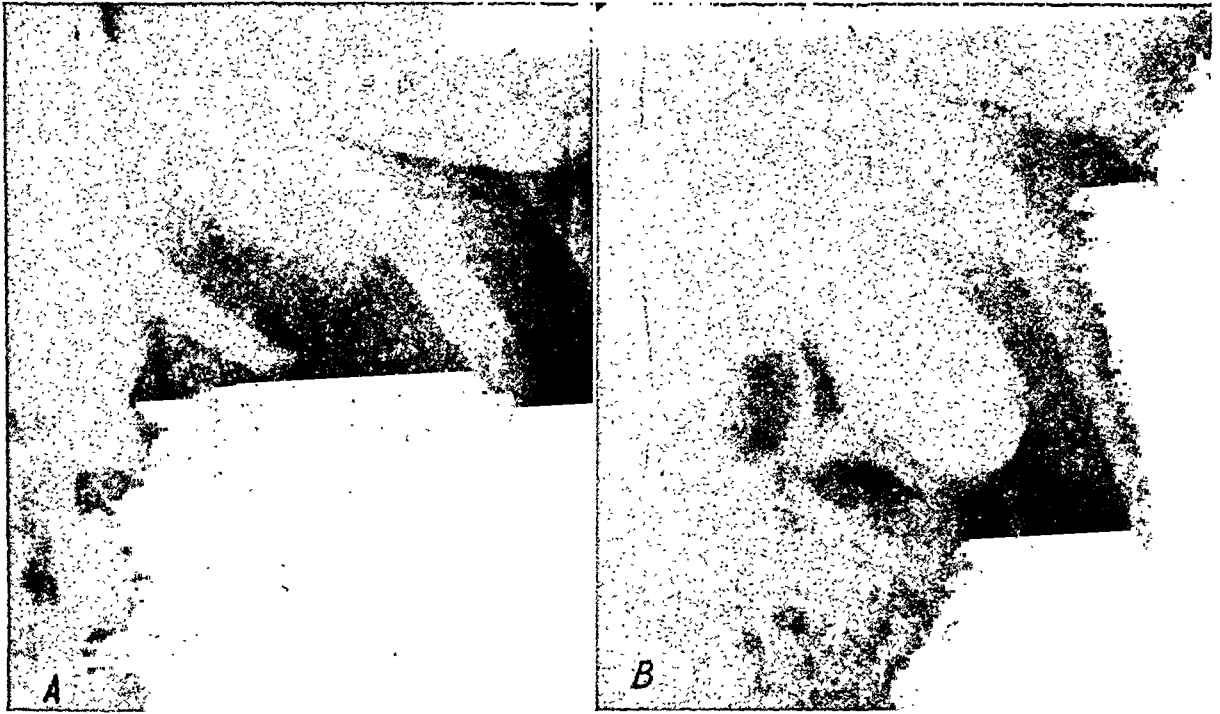


FIG. 7. *A* very faint gallbladder shadow, oral cholecystography. *B*, normal shadow two days later. *Case History.* A white female, aged twenty-nine, complained of attacks of severe abdominal pain of indefinite character. She had been on a fat free diet several days prior to oral cholecystography; the shadows were very faint. After two days on a high fat diet a normal cholecystogram was obtained.

duce these errors are obvious. When possible we insist that the patient have a fatty meal at noon the day before examination; in addition to any food desired, he must take one pat of butter, one soft boiled egg, and one glass of half milk and half cream. It is obvious that the fat meal must be given early enough to complete its action before ingestion of the opaque medium. In questionable cases re-examination after fat feeding will eliminate a significant source of error.

The routine preliminary fat meal was initiated near the middle of this series and has in no way interfered with the examination. On the contrary, there was a sharp decrease in doubtful cases requiring re-examination.

#### CONCLUSIONS

1. Physiological stasis of the gallbladder may occur when a patient has eaten no fats for a period of twenty-four hours or more. The gallbladder is filled with a thick concentrated bile.
2. Physiological stasis may cause non-

visualization of a normal gallbladder because fresh dye-laden bile is unable to enter.

3. A preliminary fat meal will decrease errors due to physiological stasis.

4. Re-examination after fat feeding is a helpful procedure in evaluating the faint gallbladder shadow.

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# ROENTGEN APPEARANCE OF DOUBLE GALLBLADDER SIMULATED BY GALLBLADDER WITH CONGEN- ITALLY FOLDED FUNDUS\*

## CASE REPORT

By RALPH E. ALEXANDER, M.D.

ROCHESTER, NEW YORK

**D**OUBLE gallbladder is a well recognized but rare congenital anomaly. In spite of its infrequent occurrence, this condition has assumed clinical importance as a result of case reports demonstrating duplication of the gallbladder in which one fundus was diseased while the other gallbladder remained normal both clinically and roentgenologically (Wischnewsky and Braun, quoted by Golob and Kantor<sup>7</sup>). It is, therefore, essential that the true anatomical state be demonstrated by cholecystography prior to operation.

Since the Graham method for visualization of the gallbladder was developed, 9 cases of double gallbladder have been reported as visualized by this method.<sup>2,3,4,5,6,7,8</sup> In some of these cases, the diagnosis was made by roentgenological examination without anatomical confirmation. A case has recently been encountered in which the roentgenograms fulfilled many of the roentgenologic criteria for double gallbladder (Fig. 1). However, further study, including lateral roentgenograms of the gallbladder area, definitely indicates that the anomaly in this case belongs to the category of "folded fundus" and not to that of a double gallbladder. As may be seen in Figure 2, the lateral roentgenogram shows a fundus folded upon itself, dividing the gallbladder into two major components, each of which was sufficiently well marked to produce its

own independent shadow and thereby simulate a double gallbladder on the posteroanterior roentgenograms. This type of gallbladder clearly falls into the category of "folded fundus" as described by Boyden.<sup>1</sup>

The clinical significance of this finding is obvious. This paper is presented to call attention to a source of difficulty in the recognition of this congenital anomaly.

101 Medical Arts Building  
Rochester 7, N. Y.

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\* From the Bath Memorial Hospital, Bath, New York.

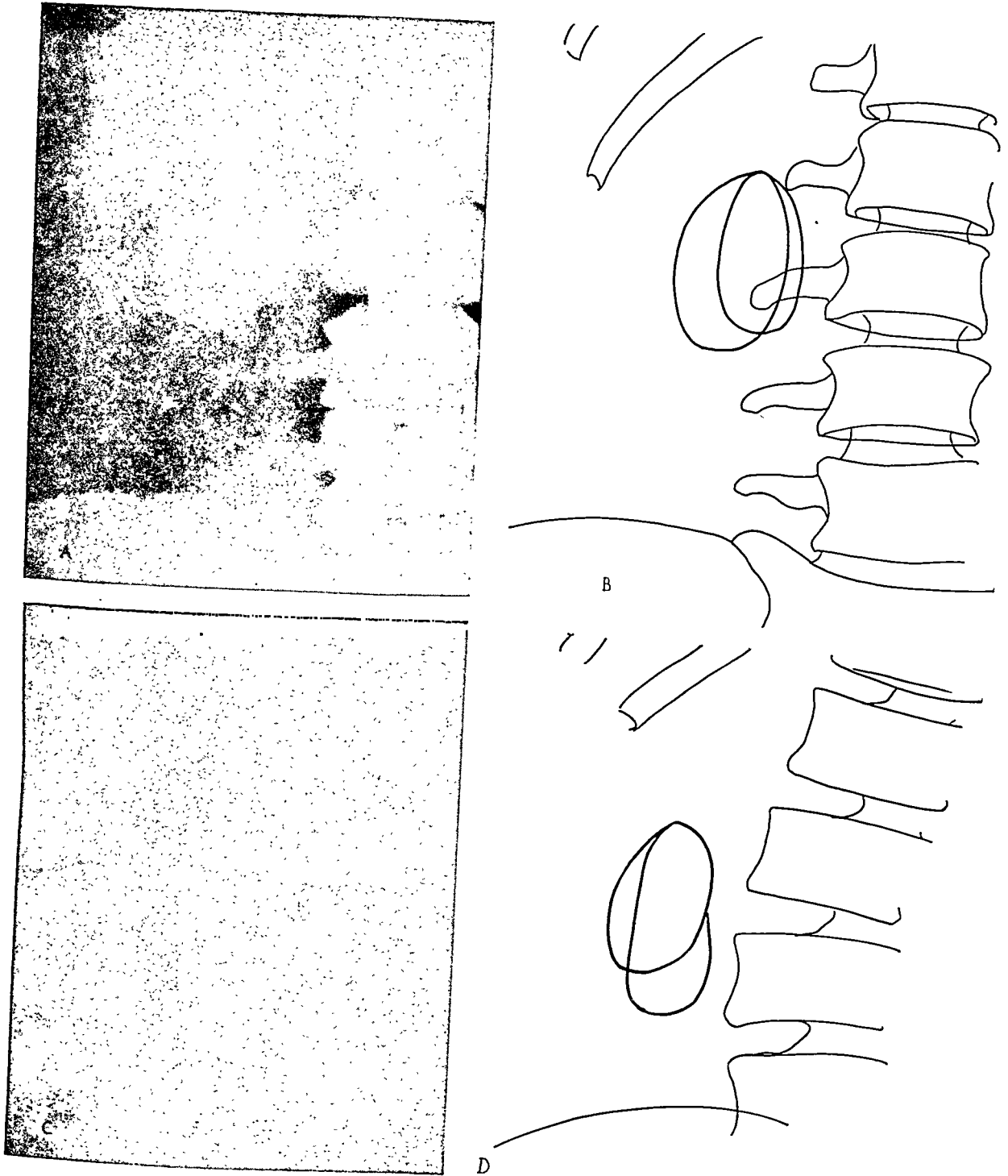


FIG. 1. Posteroanterior roentgenogram (A) and its tracing (B) show two overlapping ovoid shadows, each consistent with a gallbladder fundus. A second posteroanterior roentgenogram with 30° rotation to the left (C) and its tracing (D) again present essentially the same picture.

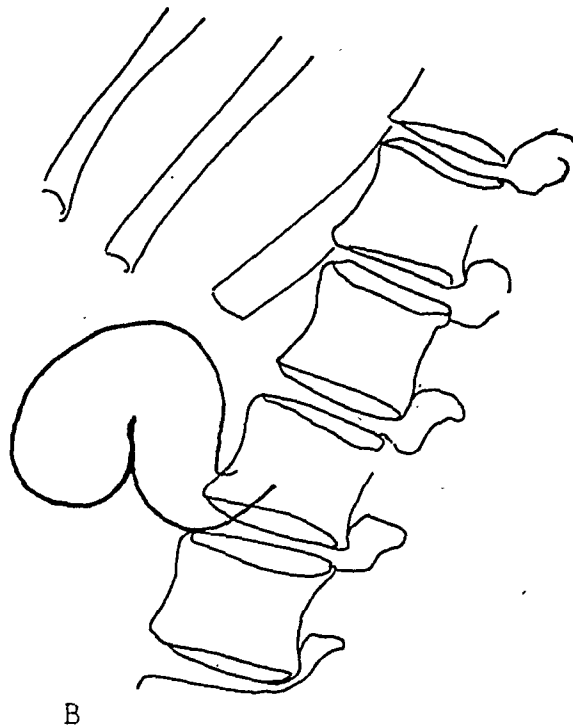


FIG. 2. Right lateral roentgenogram of the gallbladder area (*A*) and its tracing (*B*) clearly depict a "folded fundus" with superior angulation dividing the fundus into two major components.



# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Forty-eighth Annual Meeting:* Haddon Hall, Atlantic City, N. J., Sept. 16-19, 1947.

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*Committee on Arrangements:* To be appointed.

*Thirtieth Annual Meeting:* 1948, to be announced.



# E D I T O R I A L S

## ANNUAL MEETING AMERICAN ROENTGEN RAY SOCIETY

THE Forty-Eighth Annual Meeting of the American Roentgen Ray Society will be held at Haddon Hall in Atlantic City from September 16 to 19, 1947. It has been nine years since the Society last met in Atlantic City and it will be nice to return to one of those delightful meeting places where the hotel in all its aspects lends itself so pleasantly to the comfort of the members and their guests and also its entertainment facilities are unexcelled.

President Elect J. Bennett Edwards and his Program Committee have arranged a program commensurate with the importance of the meeting and the meeting place. Elsewhere in this issue of the JOURNAL will be found the Preliminary Program for the September meeting. It may be readily seen, even from this preliminary report of the forthcoming meeting, that there are papers and symposia of great interest to radiologists.

The Caldwell Lecture, on Tuesday evening, which is always one of the outstanding features of the annual meetings, will be given this year by Dr. Merrill C. Sosman and he has chosen for his topic "Cushing's Disease—Pituitary Basophilism." Dr. Sosman is Professor of Radiology of the Harvard Medical School and is chief of the Department of Radiology of the Peter Bent Brigham Hospital. He is a Past President of the American Roentgen Ray Society and from his long association with Dr. Cushing he speaks with authority upon the subject which he has chosen to discuss.

Three interesting symposia have been arranged: One by Dr. Ralph S. Bromer on Pediatric Roentgenology, another by Dr. W. Walter Wasson on the Lesser Circulation and one by Dr. U. V. Portmann on Radiation Therapy. Distinguished mem-

bers of the Society and guests will participate in these symposia.

Under the directorship of Dr. B. R. Kirklin there will again be offered the Instruction Courses. These courses are always an important part of the program of the annual meetings and as arranged by Dr. Kirklin it is assured that the courses will be well worth attending. The courses will be given each day of the meeting from two to four-thirty in the afternoon. The program of the Instruction Courses will be published in the August issue of the JOURNAL.

Among the social features of the meeting will be the annual golf tournament on Monday in competition for the Manges Trophy. This is always an enjoyable affair. During the war years this feature, for obvious reasons, was discontinued but this year marks the resumption of the tournament and this will be welcomed by all the members of the Society.

On Thursday evening the Annual Banquet will be held and during the evening dancing and entertainment have been arranged for.

As is customary a Scientific Exhibit and a Technical Exhibit will be important parts of the meeting. Dr. R. A. Arens, Chairman of the Scientific Exhibit, has arranged an instructive group of exhibits. The Technical Exhibit this year promises to be a comprehensive one as the manufacturers have shown an unusual interest in the meeting and they are arranging attractive exhibits and no doubt will display many new and important designs in roentgenologic equipment.

Those who anticipate attending the meeting in Atlantic City should make their reservations immediately by writing to Haddon Hall.



CHARLES DARWIN ENFIELD  
1887-1946

**D**R. CHARLES DARWIN ENFIELD died at his home in Louisville, Kentucky, November 14, 1946, after a protracted illness that necessitated his retirement from active practice early in January, 1946.

Dr. Enfield was born in Jefferson, Iowa, in 1887. He graduated from Rush Medical

College in 1909 after which he served as an intern in Kansas City General Hospital, Kansas City, Missouri. He entered practice in Des Moines, Iowa, in October, 1910, remaining there until May, 1921, when he moved to Louisville, Kentucky, where he practiced, specializing in radiology, from

then until the time of his retirement. He was radiologist to St. Anthony's Hospital and the director of radiation therapy at the Norton Memorial Infirmary in Louisville, Kentucky.

Dr. Enfield was a man who had many friends and was held in high respect by his associates in and out of the medical profession. He was a keen student, had an inquiring mind and many interests. He was the author of one textbook and contributed many worthwhile articles to medical literature.

Dr. Enfield was a diplomate of the American Board of Radiology, a member

of the American Roentgen Ray Society for many years; a Fellow of the American College of Physicians and of the American College of Radiology. He was a member of the American Medical Association, the Southern Medical Association, the Kentucky Medical Association and of a number of local medical societies. He was a member of the Medical Advisory Board of Selective Service during the recent war and was a member of the Association for the Study of Neoplastic Disease.

Dr. Enfield is survived by his wife and one son.

JOSEPH C. BELL



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF THE ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 16-19, 1947.

#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1948, to be announced.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Haddon Hall, Atlantic City, N. J., June 8, 1947.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Atlantic City, N. J., June 9-13, 1947.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### LOUISVILLE RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

**NEBRASKA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. O. A. Neely, 924 Sharp Bldg., Lincoln, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

**NEW ENGLAND ROENTGEN RAY SOCIETY**

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**NEW HAMPSHIRE ROENTGEN RAY SOCIETY**

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

**NEW YORK ROENTGEN SOCIETY**

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

**NORTH CAROLINA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

**OHIO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

**OKLAHOMA STATE RADIOLOGICAL SOCIETY**

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**ORLEANS PARISH RADIOLOGICAL SOCIETY**

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**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

**PORTLAND ROENTGEN CLUB**

*Secretary*, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

**RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**

*Secretary*, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

**RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

**RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.**

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

**RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

**RADIOLOGICAL SOCIETY OF NEW JERSEY**

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, New-

ark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, Shirley Savoy Hotel, Denver, Colo., Aug. 7, 8, 9, 1947.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

**SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

**SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

**SHREVEPORT RADIOLOGICAL CLUB**

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**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

**UTAH RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

**UTAH STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University

Hospital, and second six months at Toland Hall, University of California Hospital.

## CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA  
*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

## BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY  
Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)  
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

## SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

## RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

## RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## SOCIEDAD PERUANA DE RADIOLOGIA

*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

## CONTINENTAL EUROPE

## SOCIÉTÉ BELGE DE RADIOLOGIE

*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

## CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

## POLISH SOCIETY OF RADIOLOGY

First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

## WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

## ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygín and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

## SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

## PRELIMINARY PROGRAM

### FORTY-EIGHTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Forty-eighth Annual Meeting of the American Roentgen Ray Society will be held at Haddon Hall, Atlantic City, New Jersey, on September 16, 17, 18 and 19, 1947.

The Executive Council will meet at noon on Sunday, September 14.

The annual Golf Tournament for the Willis F. Manges Trophy will be held on Monday, September 15, at the Seaview Country Club, Absecon, New Jersey.

The Caldwell Lecture will be given on Tuesday evening, September 16 at 8:30 and the Annual Banquet will be held on Thursday evening, September 18.

The Scientific Sessions will begin each morning at 8:30 A.M. and the Instruction Courses will begin each afternoon at 2:00 P.M. A detailed schedule of the Instruction Courses will be published in the August issue of the JOURNAL.

The scientific program has been tentatively arranged as follows:

#### *Tuesday, September 16, 1946*

8:30 A.M. Call to order. Raymond C. Beeler, M.D., President

Address of Welcome. (To be announced.)

Installation of the President-Elect, J. Bennett Edwards, M.D.

Inaugural Address. (To be given by Ross Golden, M.D.)

9:40 A.M. Symposium on Pediatric Roentgenology. Arranged by Ralph S. Bromer, M.D.

1. Infantile Torulosis. Edward B. D. Neuhauser, M.D. (by invitation), Boston, Mass.
2. Common Roentgenologic Findings in Pyuria. Meredith F. Campbell, M.D. (by invitation), New York, N. Y.
3. Roentgen Diagnostic Criteria in Congenital Heart Disease. John W. Pierson, M.D., and John J. Douglas, M.D. (by invitation), Baltimore, Md.
4. The Skeletal Lesions in Leukemia; Roentgenographic Observations in In-

fants and Children. Frederic N. Silverman, M.D. (by invitation), New York, N. Y.

5. The Significance of Triangular Hilar Shadows in Roentgenograms of Infants and Children. Rolfe M. Harvey, M.D. (by invitation), and Ralph S. Bromer, M.D., Bryn Mawr, Pa.

#### *Tuesday, Wednesday, Thursday and Friday*

2:00-4:30 P.M. Instruction Courses

#### *Tuesday Evening, September 16, 1947*

Eight-Thirty O'Clock

The Caldwell Lecture

Merrill C. Sosman, M.D.

Professor of Radiology, Harvard  
Medical School

"Cushing's Disease—Pituitary Basophilism"

#### *Wednesday, September 17, 1947*

8:30 A.M. Symposium on The Lesser Circulation. Arranged by W. Walter Wasson, M.D.

6. The Anatomy and Physiology of the Lesser Circulation. L. R. Sante, M.D., St. Louis, Mo.
7. The Roentgen Appearance of the Chest in Certain Diseases Affecting the Peripheral Vessels of the Lungs. Robert P. Barden, M.D., Philadelphia, Pa.
8. The Heart and the Congenital Anomalies and Their Relation to the Lesser Circulation. Lewis Dexter, M.D. (by invitation), Boston, Mass.
9. The Lesser Circulation as Observed by the Anesthetist. Robert D. Dripps, M.D. (by invitation), Philadelphia, Pa.
10. The Evaluation of the Lesser Circulation as Portrayed by the Roentgen Film. W. Walter Wasson, M.D., Denver, Colo.
11. Clinical Observations of the Lesser Circulation. Leo G. Rigler, M.D., Minneapolis, Minn.

#### *Thursday, September 18, 1947*

8:30 A.M.

12. Monostotic Fibrous Dyplasia. George M. Wyatt, M.D., Washington, D. C.,

- and W. S. Randall, Jr., M.D. (by invitation), New Orleans, La.
13. The Gastric Cancer Problem: Methods of Attack and Their Present Status. Frederic E. Templeton, M.D., Seattle, Wash.
  14. Small Intestinal Motility in Dysentery. George P. Keefer, M.D. (by invitation).
  15. Pyloric Obstruction, More Accurately Demonstrated by Food-Barium Mixture. Vincent W. Archer, M.D., George Cooper, Jr., M.D., and Norman Adair, M.D. (by invitation), Charlottesville, Va.
  16. Incidence of Carcinoma of the Stomach in a Large Series of Roentgen Examinations. B. R. Kirklin, M.D., and J. R. Hodgson, M.D. (by invitation), Rochester, Minn.
  17. The Effects of Intrathoracic Pressure Changes on the Systolic and Diastolic Size of the Heart. Marcy L. Sussman, M.D., New York, N. Y.

*Thursday Evening, September 18, 1947*

Seven-Thirty O'Clock  
Annual Banquet

*Friday, September 19, 1947*

8:30 A.M. Symposium on Radiation Therapy.  
Arranged by U. V. Portmann, M.D.

18. Roentgen Therapy of Pituitary Adenomas. H. Dabney Kerr, M.D., Iowa City,

Iowa.

19. Carcinoma of the Bladder. Albert E. Bothe, M.D. (by invitation), Philadelphia, Pa.
20. Roentgen Therapy of Carcinoma of the Larynx and Pharynx. A. U. Desjardins, M.D., and F. A. Figi, M.D. (by invitation), Rochester, Minn.
21. Chondronecrosis of the Larynx following Roentgen Therapy. William A. Goodrich, M.D. (by invitation), and Maurice Lenz, M.D., New York, N. Y.
22. Post-irradiation Ulcerations of the Uterine Cervix. Harold W. Jacox, M.D., New York, N. Y.
23. Irradiation Injuries to the Urinary and Intestinal Tract Following the Use of Low Intensity Long Element Needles in the Treatment of Carcinoma of the Cervix Uteri. George W. Waterman, M.D. (by invitation), and Ellsworth Tracy, M.D. (by invitation), Providence, R. I.
24. Colloidal Lead Associated with Deep Roentgen Therapy in Bone Metastasis. Lawrence Reynolds, M.D., T. Leucutia, M.D., K. E. Corrigan, Ph.D., and James C. Cook, M.D. (by invitation), Detroit, Mich.
25. Dosage Determination with Radioactive Isotopes. L. D. Marinelli, Ph.D. (by invitation), Edith H. Quimby, Sc.D., and G. J. Hine, Ph.D. (by invitation), New York, N. Y.

#### ALABAMA RADIOLOGICAL SOCIETY

At a recent meeting of the Alabama Radiological Society the following officers were elected for the coming year: *President*, Dr. John D. Peake; *Vice-President*, Dr. L. E. Sorrell; *Secretary-Treasurer*, Dr. C. S. Stickley. Dr. Karl Kesmodel was nominated as candidate for Councilor to the American College of Radiology.

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

At a recent meeting of the Radiological Society of New Jersey the following officers were elected for the coming year: *President*, Dr. H. R. Brindle, Asbury Park, N. J.; *Vice-President*, Dr. William H. Seward, Orange, N. J.; *Secretary*, Dr. Raphael Pomeranz, Newark, N. J.; *Treasurer*, Dr. C. A. Plume, Succasunna, N. J.

#### TENNESSEE RADIOLOGICAL SOCIETY

At the recent annual meeting of the Tennessee Radiological Society the following officers were elected for the coming year: *President*, Dr. J. Cash King, Memphis, Tenn.; *Vice-President*, Dr. Franklin B. Bogart, Chattanooga, Tenn.; *Secretary-Treasurer*, Dr. J. Marsh Frère, Chattanooga, Tenn. Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, was guest speaker on the program of the Tennessee State Medical Association. He gave a most interesting and instructive paper on "The Role of Surgery and Radiation Therapy for Cancer of the Breast." He spoke to the Tennessee Radiological Society on "Roentgen Therapy for some Superficial Lesions."



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## ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

McCLURE, GEORGE. Odontoma of the nasopharynx. *Arch. Otolaryng.*, July, 1946, 44, 51-60.

As long ago as 479 B.C. Herodotus described a skull found in the battle of Plataea, in which each jaw contained teeth that were fused in a mass.

The calcified tumor is usually seen early in life, in either sex, as a slow growing, painless swelling. It is usually associated with unerupted teeth and occurs in the molar region of either the mandible or the maxilla. The tumor is an encapsulated calcified structure containing enamel, dentin and cementum. The complex composite odontoma is characterized by a conglomerate mass of calcified tooth structure composed of enamel, dentin and cementum. The compound composite odontoma, on the other hand, is an encapsulated tumor containing numerous teeth, portions of teeth or denticles.

Any tumor of the nasopharynx is uncommon, but a true odontoma of that area is rare indeed. In fact an odontoma of the nasopharynx has never before been described. The summary and comment on the case reported are as follows:

1. The character of the growth with the deciduous tooth puts it in the classification of osteofibroma of dentigerous origin.

2. The location is unusual, rare for this type of tumor.

3. The origin of the growth could not be determined, but apparently the tumor sprang from the posterior ramus of the mandible. A tumor of this type when situated within the mandible or the maxilla appears to be completely separated from the surrounding bone by its capsule; therefore, one may assume that this tumor had no attachment.

4. The audiogram reveals a typical conductive hearing loss in the left ear due either to complete obstruction or to absence of the eustachian tube.

5. The recurrence of the tumor was definitely due to a small portion of the capsule in the extreme lateral part remaining. This contained tooth remnants in the bony structure with the power of regrowth. This regrowth is typical of odontoma, with the second tooth presenting itself to the surface—in this case, the nasopharynx.

6. The recurrence of growth and the formation of a second deciduous tooth definitely put the tumor in the classification of compound composite odontoma.—*Mary Frances Vastine.*

## NECK AND CHEST

CLAGETT, O. THERON; PAYNE, JOHN H., and MOERSCH, HERMAN J. Acquired esophago-tracheobronchial fistula. *Surg., Gynec. & Obst.*, Jan., 1946, 82, 87-90.

Since the trachea and the upper part of the esophagus lie in close apposition, it is easy to understand how a pathologic process of one organ may spread and involve the other organ secondarily.

*Causes.*

1. Malignant disease of the esophagus
2. Infectious disease of the esophagus, trachea or pleura
  - A. Tuberculosis
  - B. Syphilis
  - C. Fungus infections
  - D. Suppurative esophagitis
  - E. Non-tuberculous empyema
3. Traumatic injuries of the esophagus
4. Esophageal diverticula
5. Esophagomalacia

Carcinoma of the esophagus is the most frequent cause of fistula formation. Ewald stated that 50 per cent of carcinomas of the middle third of the esophagus are associated with fistula.

*Symptoms.* As a rule, congenital tracheo-esophageal fistulas manifest their presence at once by a definite group of symptoms; acquired fistulas may be present for varying periods before they produce symptoms. There is usually a history of varying degrees of dysphagia gradually increasing in severity. Then suddenly cough develops as well as dyspnea when the patient eats and he raises purulent sputum and occasionally blood.

*Treatment.* When fistula arises from malignant disease, there is no treatment available. Some of the other types of fistula are amenable to various forms of therapy. Clerf, Cooley, and O'Keefe have reported 2 cases in which esophago-tracheal fistula was successfully treated by the application of crystals of sodium hydroxide.

Imperatorii has reported a case in which a high fistula was treated by excising the fistulous tract and closing the esophagus and trachea separately with interrupted sutures.

When these fistulas arise from empyemas, Cohen and Sindell advocate adequate drainage of the pleura and prolonged esophageal rest by the use of nasal tube feedings or gastrostomy

feedings. This regimen is followed until the esophageal fistula has had adequate time to heal.—*Mary Frances Vastine.*

LAHEY, FRANK H., and FICARRA, BERNARD J.

The lateral aberrant thyroid. *Surg., Gynec. & Obst.*, June, 1946, 82, 705-511.

Forty-seven tumors of lateral aberrant thyroid origin were encountered at the Lahey Clinic up to July 1, 1945. During this same period 25,000 patients were treated for various types of goiter. Thus, one tumor of this type is seen in approximately every 500 goiter patients.

As a result of their investigations along this line, the authors arrive at the following conclusions:

1. Tumors of lateral aberrant thyroid origin arise from the ultimobranchial body as a result of departure from normal embryologic development.

2. These tumors may occur in patients of any age, but they are seen more often under forty years of age—in women.

3. The diagnosis can usually be made clinically and this must be confirmed by biopsy.

4. The differential diagnosis must include tuberculosis, lymphosarcoma, Hodgkin's disease, inflammatory glands, metastatic carcinoma, the simple neck tumors, branchial cysts, carotid body tumors and neurofibromas.

5. The characteristic pathologic picture is a papillary cystadenomatous structure showing little, if any, differentiation into adult thyroid structure. All these tumors must be considered as actually or potentially malignant.

6. Radical neck dissection followed by deep radiation therapy is the most satisfactory course of treatment. This lesion is of low malignancy and is radiosensitive.

7. The operative mortality in 47 cases was zero.

8. Follow-up studies of 30 patients prior to 1939 cover a period of five to fifteen years. Twenty-one of these patients showed no recurrence; 4 had recurrence, were reoperated upon, and have remained well. Four died of other causes. One patient died of recurrent malignant disease of lateral aberrant thyroid origin.

9. Follow-up study of the authors' most recent 17 cases encompasses the past six years. One patient had a recurrence, was reoperated upon twice and has remained well.

10. Whenever a biopsy specimen is taken of a tumor from the lateral region of the neck, and

the report is papilliferous cystadenoma or papillary adenocarcinoma, in all probability it is a lateral aberrant thyroid.—*Mary Frances Vastine*.

LELL, WILLIAM A. Bronchoscopy as an aid in the diagnosis and treatment of allergic pulmonary disease. *Arch. Otolaryng.*, Jan., 1946, 43, 49-58.

*Bronchoscopic Diagnosis and Treatment of Conditions Simulating Asthma.* A foreign body may produce symptoms of asthma. This is true particularly in children, with whom a history of foreign body may be entirely unsuspected. *The routine in the roentgen examination of these patients includes:* (1) anteroposterior and lateral projections of the neck; (2) inspiration and expiration roentgenograms of the chest in both the anteroposterior and lateral view; (3) a careful fluoroscopic study with an opaque mixture and (4) roentgenograms of the swallowing function.

In a review of the record of 176 children admitted for bronchoscopic examination because of symptoms simulating asthma, which had not readily responded to the orthodox treatment, the following diagnoses were made:

Retropharyngeal abscess.....	1
Foreign body in larynx.....	5
Organic changes in the larynx.....	8
Tracheal compression.....	14
Bronchial foreign body.....	13
Esophageal foreign body.....	5
True asthma, little secretion.....	47
True asthma, thick secretion.....	83

*Characteristic Bronchoscopic Findings in Allergic Pulmonary Disease.* The author's observations in a large number of cases of asthma have not confirmed the classic description of the blanched appearance of the mucous membrane and the presence of thick, sticky secretion purported to be associated with asthma.

The same person may present entirely different findings at different times depending on whether the examination is made while the patient is suffering from an acute attack or at a short or a long interval after an attack. This is particularly true of children. If the examination is made at a long interval after an attack, a practically normal appearance is presented, the mucous membrane being smooth and velvety with absence of inflammatory reaction or expiratory collapse of the posterior tracheal wall.

On the other hand, in all patients examined during an attack, whether children or adults,

the changes are fairly constant and uniform: The mucous membrane is hemorrhagic, red and redundant, greatly reducing the caliber of the lumen of the trachea and both main bronchi. Secretions are always present and so tenacious that they are difficult to aspirate. The classic phenomenon of collapse of the posterior tracheal wall is frequently present in children and almost always present in adults during status asthmaticus.

*Pathologic Changes in Status Asthmaticus.* (1) Engorgement of the epithelial cells, thickening of the basement membrane, hypertrophy of the muscle bundles and increase in size of the mucous glands. (2) Marked prominence of the lymphoid connective tissue and eosinophilic cells in the subepithelial and extramuscular layers.

*Bronchoscopy in the Treatment of Asthma.* An uncontaminated specimen of secretion from the bronchial tree can be obtained. By determining the type of organism present, the proper drug can be administered. (These drugs may be administered bronchoscopically with unusually effective results.)

Autogenous vaccine is a valuable adjunct to therapy in these patients. In the majority of cases the vaccine serves to immunize the patient against the organisms which he harbors and renders him less susceptible to recurrent infections of the respiratory tract. The author's observations have shown that in at least 65 per cent of the patients, attacks of status asthmaticus were preceded by acute infections of the respiratory tract. The roentgen examination of the chest during this phase revealed marked accentuation of the hilar markings and, in many cases, even of the mediastinal shadow.

Of great importance during the bronchoscopic aspiration is the hypodermic injection of a solution of epinephrine hydrochloride made just before the bronchoscopy. The secretion is more readily aspirated and the patient experiences more promptly, effective and permanent relief following the injection of epinephrine (or theophylline ethylenediamine).

*Bronchoscopy in the Treatment of Status Asthmaticus.* A series of 269 bronchoscopic examinations and aspirations have been performed on 102 patients. In all cases, during the bronchoscopic examination oxygen was administered through an attachment on the bronchoscope, thereby relieving the dyspnea.

Of utmost importance in the treatment of patients subject to asthmatic attacks, if the

greatest relief is to be obtained, is that they be given the treatment as soon as possible during an attack, whether it is in the middle of the night or during the day.—*Mary Frances Vastine*.

HARTZELL, HOMER C., and MININGER, EDWARD P. Bronchopneumonia following ether anesthesia in obstetrics. *Surg., Gynec. & Obst.*, April, 1946, 82, 427-433.

A series of cases of bronchopneumonia has been observed in patients on the obstetrical service at Cleveland City Hospital. These bronchopneumonias, observed within a few days following delivery, were variable in extent, transient in nature, and were not associated with clinical evidence of serious illness. They were discovered in almost all cases by means of a roentgenogram of the chest made to investigate the significance of slight fever or rales in the chest developing after delivery. The anesthesia in these cases consisted of ether administered usually by the open method and preceded by varying quantities of barbiturate and other premedication. The mechanism by which the pneumonias were produced was probably the aspiration of mucus or vomitus during or following anesthesia. Other factors which may be considered are suppression of cough reflex and retention of secretions due to the irritation of ether.

*Evaluation of Study.* The frequent involvement of the right side as compared with the left may be explained by the more vertical course and larger caliber of the right main bronchus as compared with its fellow on the left. Similar predominance of right-sided involvement has been observed in aspiration of foreign bodies and in lung abscess.

The lobar distribution of the aspiration pneumonias emphasizes merely that in bed patients such changes are not confined to the bases, but may occur anywhere in the lungs.

There was no correlation between the extent of the pneumonia and the quantity of sedative medication administered.

No difference was apparent in the clinical course of those patients treated with chemotherapy and those left untreated.

Vomiting is known to have occurred during anesthesia or labor in 9 of 20 cases in this series. It is possible that in additional cases vomiting took place prior to anesthesia or following its completion, but was not recorded. It is also possible that the aspiration of mucus,

in the absence of frank vomiting, may result in aspiration pneumonia.

*Roentgenologic Findings.* In localization, involvement of the right side was more frequent than the left. Involvement of the upper lung was more frequent than the lower. The most frequent single site of localization was the right upper lobe area.

The less extensive cases have presented the picture of "soft" fluffy localized shadows of increased density which, when situated in the upper lung fields, closely simulate the early infiltrations of adult tuberculosis.

The more extensive bilateral cases have shown symmetric extensive coalescent densities, with tendency to central localization, simulating the picture of pulmonary edema.

Usually an associated generalized increase in prominence of the vessel markings has been found, suggestive of pulmonary hyperemia. None of the patients have shown mediastinal displacement or other evidence of massive atelectasis.

Clearing of the infiltration was rapid in most cases and complete in all. Fifteen of 18 cases in which serial films were available showed complete clearing in one week or less.

On strictly objective criteria, a roentgenologic diagnosis of aspiration pneumonia is not possible, but its recognition is usually easy if the roentgenologist has the clinical findings available to him, and if he is familiar with the condition.

*Summary and Conclusions.* A series of 20 cases of bronchopneumonia developing following obstetrical delivery in which ether anesthesia was used have been observed.

The chief cause was the aspiration of gastric contents as a result of vomiting. The following were probably contributory: (1) preanesthetic medication favoring suppression of the cough reflex, (2) prolonged gastric evacuation in labor, (3) fluidity of gastric contents, favoring their dissemination in the bronchial tree.

The bronchopneumonias varied in extent from small isolated patches to extensive bilateral infiltrations.

Clinically they did not prove a cause of serious illness and no fatalities resulted. Chemotherapy by sulfonamide drugs was apparently not effective.

Roentgenologically, the problem was one of differentiation from pulmonary tuberculosis, sarcoidosis, other pneumonias, pulmonary edema, and atelectasis.—*Mary Frances Vastine*.

AUERBACH, OSCAR. Laryngeal tuberculosis.  
*Arch. Otolaryng.*, Aug., 1946, 44, 191-201.

In the course of autopsies by the author and his colleagues, the larynx was routinely examined for gross and microscopic pathologic changes. An opportunity was thus afforded to study the mode of development and the progression of laryngeal tuberculosis as well as its relationship to tuberculosis in other parts of the body.

*Conclusions:*

1. Laryngeal tuberculosis was present in 37.5 per cent of the cases of tuberculosis (304) which came to autopsy.

2. In all but two instances it developed as a direct infection from positive sputum in chronic pulmonary tuberculosis.

3. The age, sex and race distributions in this series parallel those in chronic pulmonary tuberculosis, i.e.,

Age: 20-39 years

Sex: 208 males to 96 females.

Race: 185 Caucasians, 116 Negroes and 3 Asiatics.

4. Tuberculous foci, with and without central zones of caseation, form in the walls of the larynx as a result of tubercle bacilli which enter through the ducts of the mucous glands. Ulceration develops either through pressure atrophy of the mucous membrane by the tuberculous foci or by caseous necrosis of the overlying epithelium as the tuberculous areas enlarge. The further progression of the ulcerative process is similar to that in other parts of the body. Ulcers were found most frequently on the true vocal cords (47.1 per cent).

5. Healing may occur in any stage of anatomic development, usually in cases in which the underlying chronic pulmonary tuberculosis undergoes anatomic healing. In some instances healing and progression keep pace in the same larynx, resulting in a pronounced thickening of the wall, nodular protrusions into the lumen and narrowing of the canal.—*Mary Frances Vastine.*



# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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No. 2

## AN EPIDEMIC OF INHALATION LEAD POISONING WITH CHARACTERISTIC SKELETAL CHANGES IN THE CHILDREN INVOLVED

By GEORGE COOPER, JR., M.D.

*Hospital of the University of Virginia*

UNIVERSITY, VIRGINIA

EPIDEMICS of poisoning due to inhalation of lead dust or fumes have been reported in other medical literature but not in the radiological literature.

About 300 B.C., Hippocrates recorded his findings in a case of lead colic in an extractor of metals.<sup>18</sup> The clinical picture of the various manifestations of plumbism have been described many times since. In France, lead contaminated wine has produced numerous epidemics, reported at intervals during the past four hundred years.<sup>18</sup> In the writings of Benjamin Franklin are found references to cases of lead poisoning from drinking New England rum. Most "New England rum" was distilled in the Boston area, and the Colony of Massachusetts showed an early interest in public health by inscribing on its statute books, in 1723, a law forbidding the use of lead parts in apparatus for the distilling of rum.<sup>10</sup> In 1767, Sir George Baker traced the cause of "Devonshire colic" to lead in storage containers of cider which, in its mellow state, was then a popular beverage in southwest England. Tanquerel des Planches in 1839 first described all the

manifestations of saturnism in one treatise.<sup>18</sup>

With the coming of the Industrial Revolution, lead intoxication became increasingly common, and remained so until about 1910 when industrial hygienic conditions began improving. In many instances, industrial poisoning was due to inhalation of lead fumes and dust rather than to ingestion of contaminated material. In 1909, Goadby<sup>11</sup> reported that animals confined in an atmosphere containing lead dust developed toxic symptoms more quickly than did animals fed ten times as much lead. Later Aub noted that when insoluble lead salts were introduced into an animal's trachea, lead was found in the tissues only a few hours later. Absorption of lead from the respiratory tract being more complete and rapid than from the alimentary tract or skin and mucous membranes, and the liver excreting a large amount of the lead absorbed from the intestinal tract, toxicity from inhalation develops more rapidly and is more severe.<sup>3</sup>

From the roentgenologist's standpoint, lead poisoning in adults is of little interest,

for the metal is deposited in roentgenologically demonstrable concentration only in actively calcifying bone—that is, in the metaphyses of children's bones, in healing fractures, and in bone regenerating following radiation therapy of destructive tumors, primary or metastatic. Since induced lead poisoning is no longer used in the treatment of cancer, roentgen evidence of lead poisoning in adults is extremely rare. Roentgen evidence of lead poisoning in children, on the other hand, is not infrequently encountered.

Prompt recognition of plumbism in children is more important than in adults, for children react to smaller dosage and more severely. In epidemics of lead poisoning in which both children and adults have been exposed in the same manner and amount, children are uniformly found to be more susceptible, particularly those under four years of age. It has also been noted that individual response to the same degree of poisoning varies considerably, some persons developing toxicity much more readily than others.<sup>13</sup>

#### SOURCES OF LEAD

Many of the cases of lead poisoning in children reported in this country have been due to abnormal appetite, leading to ingestion of dirt and trash and to persistent sucking and chewing of anything that can be put in the mouth. The number of such cases fell off rapidly when the danger of lead toys was appreciated and when the use of lead paint on woodwork and children's furniture and toys was stopped. Lead nipple shields, lead foil and food wrappings, lead cooking utensils, and lead pipes carrying slightly acid drinking water are other sources which have largely been eliminated. Lead-containing ointments, lotions, and dusting powders used on irritated nipples are still the source of an occasional case of lead poisoning in nurslings. In adults, hair dyes, lead acetate douches, and astringent mouth washes have been known to produce plumbism.

In Japan, poisoning in nurslings was ex-

tremely common because there were no laws prohibiting manufacture of white lead rouge, toilet and baby powders. Japanese women used large amounts of powder on their faces, necks, shoulders, and breasts. They absorbed enough lead to render their milk toxic to the infants while themselves remaining free of clinical symptoms.<sup>12</sup>

In Queensland, Australia, numbers of children were poisoned by lead paint used on verandas and other outdoor woodwork, due to inhalation of lead dust as well as to ingestion of the paint. In the hot, dry climate of Queensland, the paint was quickly reduced to a powder dangerous to children with healthy appetites as well as to those suffering from pica.<sup>18</sup>

In 1933, epidemics of lead poisoning were reported in Nashville by Crutcher<sup>9</sup> and in Baltimore by Williams and others,<sup>21</sup> in which, for the first time, the source of lead was traced to the use of storage battery casings for fuel. In the Baltimore epidemic, junk dealers, after salvaging the lead plates from the batteries, had, with the best intentions, sold at small cost or, in some cases, given away the useless casings to destitute families. The casings were encrusted with lead sulphate and lead peroxide. They burned with an intense but smoky flame. The leaky cook stoves in which they were used permitted volatilized lead to escape with the smoke into the congested rooms of these poor homes and apartments. The result was 40 known cases of lead poisoning. The report of this epidemic was published in the *Journal of the American Medical Association*, and aroused immediate interest. Cases of plumbism from the same cause were promptly reported in Philadelphia, Long Island, and Detroit.

Similar epidemics have since been reported in Lexington, Kentucky,<sup>1</sup> and New York City,<sup>4</sup> as well as scattered cases. The use of battery casings for fuel was resorted to because of poverty. In Staunton, Virginia, it was recently discovered that wartime scarcity of fuel had led another marginal neighborhood to burn discarded

battery casings. Seventeen out of 18 children investigated were found to have latent or toxic plumbism. The eighteenth had spent only the three summer months at home during the past four years.

#### SYMPTOMATOLOGY

The symptomatology in poisoning due to lead inhalation is identical with that due to lead ingestion.<sup>13</sup> The early symptoms are gastrointestinal—loss of appetite, vomiting, constipation, and abdominal cramps. The cramps have occasionally led to exploratory laparotomy in cases of acute poisoning. Persistent and more severe poisoning frequently leads to peripheral neuritis and palsy in adults; in children, occasionally. Symptoms due to anemia are usual in both, but the most dangerous manifestation of plumbism is meningo-encephalitis, frequent in children, comparatively rare in adults. From ingested lead, the incidence is highest in spring and summer because the vitamin D producing action of sunlight increases absorption of ingested lead as well as calcium.<sup>17</sup> There is no seasonal incidence from inhaled lead. This serious development is marked by more persistent, projectile vomiting, by change in the victim's mental state—irritability, lethargy, etc.—by visual disturbances, and by alterations in pulse and respiratory rates. These initial symptoms are followed by delirium, stupor, coma, elevated blood pressure, choked optic discs, convulsions, and separation of the cranial sutures. If the patient survives, cortical and optic atrophy are frequent sequelae.

Since there is no specific treatment for lead encephalitis, recognition of plumbism in an earlier stage is the only means of preventing permanent central nervous system damage and fatalities.

#### DIAGNOSIS

The diagnosis of lead poisoning rests on the same findings, whether the metal is ingested or inhaled.

Encephalitis with a history of preceding gastrointestinal disturbances should arouse

suspicion. Instances have been reported in which children have had exploratory craniotomies with a preoperative diagnosis of central brain tumor, a postoperative diagnosis of serous arachnoiditis—and a final diagnosis of lead poisoning.<sup>5</sup>

Anemia is a fairly constant finding but of course not diagnostic. Basophilic stippling of the red blood cells is neither diagnostic nor constant, but is frequent during acute plumbism and during flare-ups due to infections. Stippling in large numbers of red cells is usually due to lead poisoning.

Lead lines in the gum margins are frequently found in adults, in children seldom. On the other hand, in children, black deposits on the necks of the teeth are frequent.<sup>12</sup>

Lead may be identified by spectroscopic examination of blood and spinal fluid. Quantitative determination of the amount of lead in the urine and stools is sometimes helpful, especially in adults who do not exhibit roentgenographic evidence. The vast majority of people have a little lead in their systems all the time. Since lead in the feces in indeterminate percentage simply passes through the intestinal tract without having been absorbed and excreted, quantitative analysis of the urine is more informative. Excretion of 0.05 to 0.1 mg. of lead daily in the urine is considered within limits of normal.<sup>2</sup>

But in children, the single most valuable diagnostic procedure, the quickest, the most reliable, and the easiest is roentgenographic examination of the skeleton.

#### ACTION OF LEAD IN THE BODY

Before describing the roentgen findings, the effect of excessive absorption of lead should be briefly reviewed.<sup>2,3,18,20</sup> Whether absorbed from the lungs or intestinal tract, lead is conveyed in the blood either as a highly dispersed, colloidal, insoluble triphosphate or as a soluble diphosphate, to all the tissues. Anemia is due to actual destruction of red blood cells. Deposit of insoluble lead phosphate on the surface of the cells alters their colloidal state. They



shrink, become brittle, and are quickly broken up. Lead deposited on the surface of reticulocytes produces clumping of the basophilic substance in the cytoplasm, which is seen as stippling.

The lactic acid in fatigued muscle cells leads to fixation of lead on the cell surfaces in a complex chemical reaction which is not clearly understood. The resultant damage, depending on its degree, is primarily responsible for peripheral neuritis in lead poisoning. Pathological changes are found in the nerves supplying the muscles, but the primary damage seems to be in the muscles themselves. The most used muscles are most often affected because they produce the most lactic acid.

In the brain, persistent high concentration of lead salts in the blood stream produces an intense meningeal irritation and cerebral edema. If the ischemia induced by the edema lasts long enough to devitalize many cells, cortical and optic atrophy follow. The mechanism of the effect of lead on the meninges and cerebrum is not clear. Injection of lead salts into the brains of animals produces only focal necrosis, but injection into the cerebrospinal fluid through cisternal punctures produces encephalitis.

Hydrogen sulphide, released from decaying protein between the teeth or from decaying gum tissue in the presence of pyorrhea, combines with lead salts to produce lead sulphide deposits on the teeth or fine subepithelial deposits in the gum margins.

The mechanism of the action of lead on the intestinal tract is not understood. All that is known is that the motility of smooth muscle is diminished while the tone is increased. Constipation and intense spasm of both large and small bowel result.

Lead absorbed from the respiratory tract, intestinal tract or skin and mucous membranes is diffused through the body by the blood stream, but the lead absorbed from the intestinal tract has first to get through the liver. A large percentage of lead in the portal circulation is excreted by the liver in bile. After entering the general circulation, some of the lead is excreted by

kidneys and liver, the rest follows the calcium stream, and in a few days, the blood is free of lead, all of it having been excreted or stored in the skeleton, as tri-lead phosphate. In bone it is harmless. Lead and calcium are utilized by bone interchangeably. If a lead solution of known concentration is pumped over crushed bone, analysis of the filtrate shows absorption of lead and release of a proportionate amount of calcium.

#### ROENTGEN EVIDENCE OF PLUMBISM

In the winter of 1930-1931, Vogt and Park reported consistently finding, in cases of clinical lead poisoning in young children, homogeneous metaphyseal densities.<sup>19</sup> The zones of increased density varied in width up to about 0.5 cm., and the width and density was in proportion to the length and intensity of exposure to lead. The zones were clearly defined and sometimes double zones were present. Where bone growth was most active, in the ends of the long bones, at the anterior ends of the ribs, and in the iliac crests, the metaphyseal densities were most marked. No other bone changes were noted, except separation of the cranial sutures in cases complicated by encephalitis. Parks, describing the autopsy findings in a fatal case of plumbism, noted hyperplasia and crowding of the trabeculae in the zones of increased density.<sup>14</sup> Chemical analysis of various portions of the bones showed, according to Aub, a concentration of lead in the dense zones four times as great as in the mid-cortex. These two factors, crowding of the trabeculae and lead concentration, were accepted as responsible for the roentgen appearance. Caffey<sup>6</sup> confirmed these findings in a report of a postmortem of a child who died of lead encephalitis. In poisoned growing dogs, he found that chemical analysis showed lead throughout the bones but much higher concentration in these zones of increased density, a concentration which could not be produced in adult dogs. Caffey<sup>6</sup> and Vogt<sup>20</sup> described resolution of these zones after cessation of exposure to lead. As the extremities increase in length, the zones are

seen to become broader and less dense, sometimes eventually fading entirely, sometimes leaving fine dense transverse lines in the diaphyses and fine dense rings in the epiphyseal centers of ossification and in the carpal bones.

With cessation of lead absorption, the lead in the skeleton is slowly released, in the normal course of events, into the blood stream, just as is calcium, where it is partly excreted and partly redeposited in bone. In children, partial reconcentration in the metaphyses leads to the widening and diminished density of the white zones. Too rapid deleading or acidosis secondary to infections results in high enough blood concentrations to produce clinical symptoms of plumbism again. This and episodes of fresh lead absorption presumably produce double zones of density.

Zones of increased density in the metaphyses are produced by conditions other than plumbism.

1. Sometimes normal metaphyses are calcified more heavily than the average.

2. Inorganic phosphorus produces increased density at the ends of the diaphyses by causing multiplication and crowding of the developing trabeculae.<sup>15</sup> When yellow phosphorus was used in the treatment of rickets, the condition was relatively frequently encountered, developing after about five weeks of such treatment. Usually the zones of abnormal density are wider than "lead lines," extending beyond the metaphyses, and prominent bands are seen in the center of ossification of the epiphyses as well as in the ends of the diaphyses.

3. Bismuth produces the same changes in children's skeletons as does lead. Bismuth lines are usually acquired during fetal life as a result of antiluetic treatment of the mother. Lead lines are usually more prominent and more dense.<sup>8</sup>

4. Abnormal metaphyseal densities have been observed in infants deficient in vitamin A, suffering from nutritional disturbances of unknown etiology, from bacteremia, from hematogenous, disseminated tuberculosis, and from erythro-

blastosis fetalis. A more common cause of transverse metaphyseal densities is congenital syphilis.<sup>8</sup> The history and clinical findings in all these conditions ordinarily offer ready differentiation from plumbism. Also, the bone changes in these conditions are found in very young infants. Skeletal changes in Japanese infants nursing lead poisoned mothers are reported as appearing at the age of five or six months.<sup>12</sup> Two three month old infants in the group which is the subject of this report showed other evidence of plumbism but no roentgen changes.

5. In the presence of active rickets and lead poisoning, deposition of lead in the metaphyses, as well as of calcium, cannot take place, and the "lead lines" therefore do not develop.<sup>7</sup> In healing rickets, when calcium is being laid down rapidly in the ends of the diaphyses, recognition of lead deposit may be difficult. In healed rickets, the density of the metaphyses simulates saturnism, but the other bone changes, flared metaphyses, bowed shafts, cortical thickening on the concave side of the bowed bones, are not produced by lead poisoning.

6. The dense lines seen in scurvy at the cartilage-bone junctions are narrower than "lead lines," and scurvy produces other characteristic changes.

7. In very young children, three years old and under, the earliest manifestation of marble bones is metaphyseal density which cannot be differentiated roentgenologically from "lead lines."<sup>16</sup>

The diagnosis of lead poisoning cannot be made without confirmation from the history and clinical findings, but in children metaphyseal densities in the most actively growing bones are the most consistent and reliable evidence available.

The epidemic which is the occasion for this report was discovered because one of the victims was roentgenographed. Until then, lead poisoning had not been considered.

A white child, aged eighteen months, was referred to the pediatric out-patient department with the following history: He had been



FIG. 1. Case 14. No roentgen changes but stippled red blood cells in a three months old infant.

in good health until eleven months of age when, in a period of twenty-four hours, to the accompaniment of persistent, violent vomiting, he had ten convulsions. During the succeeding week, nausea and vomiting persisted. Convulsions recurred, and he was hospitalized with a diagnosis of intestinal influenza and increased intracranial pressure. Put on a sulfa drug, improvement was rapid, and he was discharged in thirteen days. Between that time and referral, two attacks of tonsillitis were accompanied by convulsions. One week before being referred, the child began dragging his right foot, and the neck and back became stiff. Examination in the pediatric clinic revealed dirty deposits on the teeth, hypertrophied, infected tonsils, a stiff neck and back, and partial flexion of the right leg. Motion was limited and painful. Roentgen

examination of the spine was requested, "diagnosis deferred". The pelvis was included on the roentgenograms. A zone of sharply increased bone density 4 mm. wide was observed in the metaphyses of the iliac crests and upper ends of the femurs, paralleled by a very narrow zone of similar density. Examination of the rest of the skeleton showed metaphyseal densities in all the long bones, and in most of them, the narrower parallel shadow higher up the diaphyses. The cranial sutures were separated. A blood smear revealed large numbers of stippled red blood cells.

On further questioning of the mother, it was found that the child had no abnormal appetites, and there was no history of gastrointestinal disturbances other than the nausea and vomiting accompanying the convulsions. But the family had used discarded battery casings for fuel consistently for between two and three years. The family lived in a marginal settlement on the outskirts of town, and all the families in this neighborhood had used the casings in varying amounts. A large junk yard nearby, after salvaging the lead plates from old batteries, sold the discarded casings at a minimal cost and sometimes gave them away. The smoke from the casings was heavy and had a disagreeable odor, but wood and coal had been scarce and expensive since shortly after the beginning of the war.

This family's home was typical of the neighborhood. A fire was kept going in the kitchen cook stove the year round, for cooking, heating water, and heating the house. Several of the houses had oil stoves in a bedroom, most did not. The firebox in the cook stoves was directly beneath the lids. Even when closed, some smoke leaked from the fire box and flue, and of course, whenever the door to the fire box was opened or a lid lifted, large amounts of smoke entered the room. In bad weather, the family spent most of its time in the kitchen, the only warm room in the house. But the odor of burning batteries was heavy out of doors as well as in, especially on still, damp days.

At the request of the pediatric and roentgen departments, welfare workers persuaded most of the families in the neighborhood to allow their children to be examined. Significant findings are summarized in the accompanying table and chart. All the families examined were

white. The two which refused were colored. All were of low intelligence, suspicious, and reluctant to answer questions, apparently being fearful of punishment because of their use of the casings. Despite reas-

genograms illustrate the varying degrees of bone changes found.

Noteworthy were the following findings:

1. Out of 19 patients examined, whose ages ranged from three months to twenty

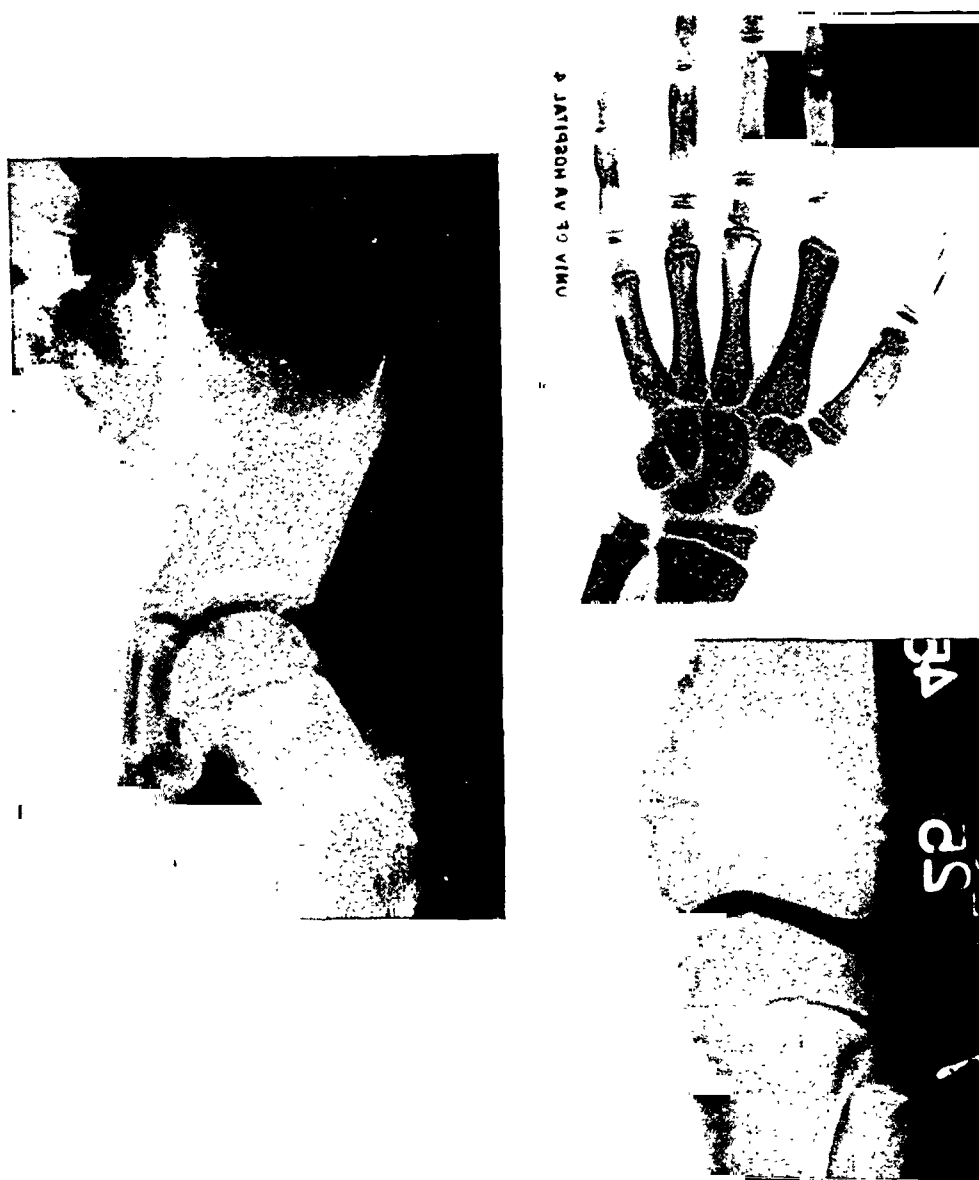


FIG. 2. Case 2. One plus roentgen changes. A zone of abnormal density 2 mm. wide in the lower femoral metaphysis, a dense zone in the distal radial metaphysis, and barely demonstrable density in the edge of the iliac crest, the upper femoral, upper tibial and upper fibular metaphyses.

surances on that score, their stories were contradictory. Some admitted use of the batteries only when confronted with testimony of neighbors. While some of the details are probably incorrect, the general picture is accurate. Reproductions of roent-

years, only 4 showed no abnormal metaphyseal densities on roentgen examination.

Case 15, a twenty year old girl, was roentgenographed to see whether lead deposits could be recognized along recently fused epiphyseal lines. Either the rate of growth

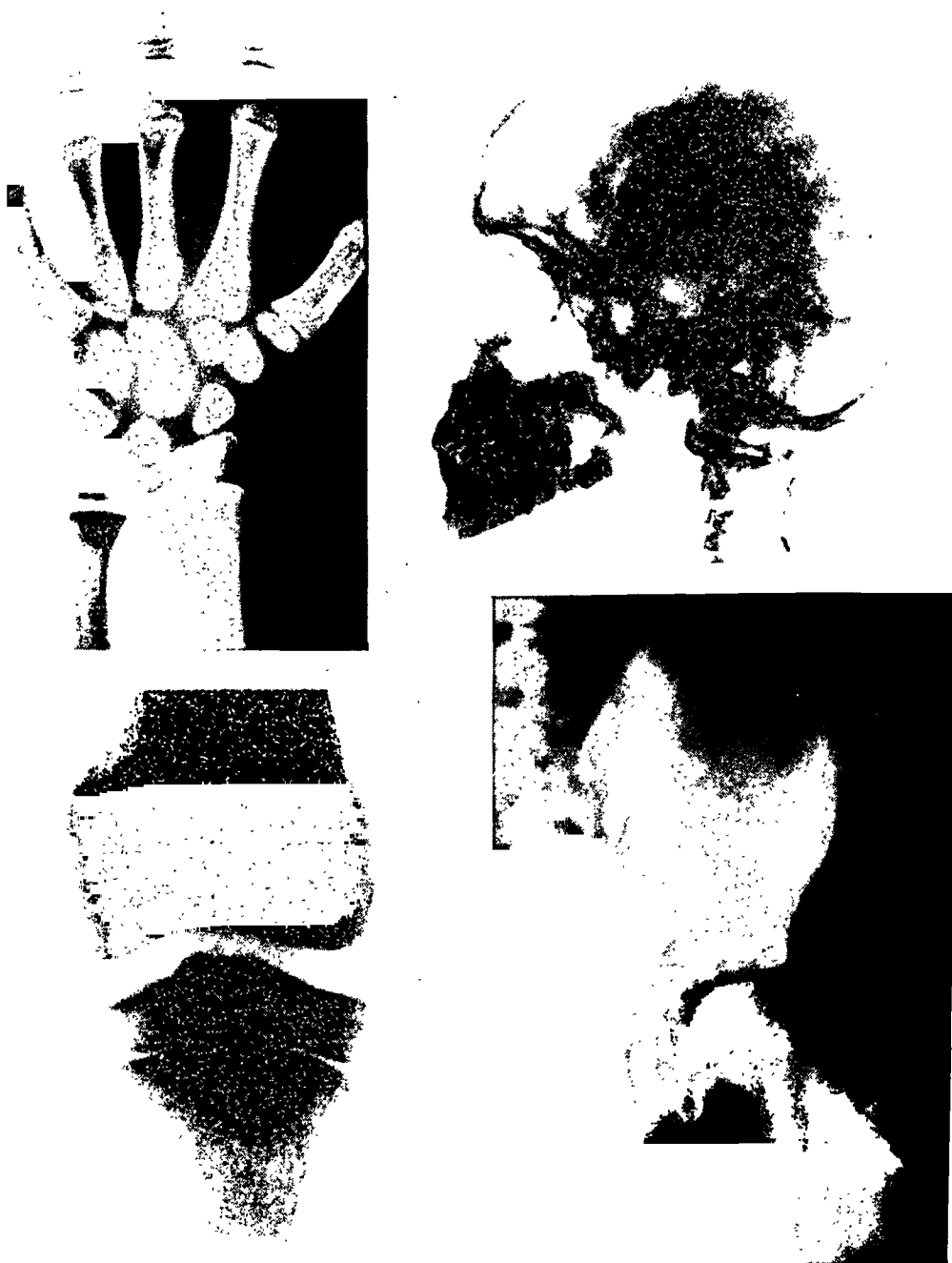


FIG. 3. Case 11. Two plus roentgen changes. A zone of abnormal density 5 mm. wide in lower femoral metaphysis, definite shadows in the other metaphyses. The cranial sutures are a little loose and the convoluted markings are unusually prominent. The patient had episodes of headaches and vomiting.

during exposure was too slow to concentrate lead in recognizable quantity, or fusion had been followed quickly by redistribution of metaphyseal lead and calcium.

Case 8 was a seventeen year old girl who had spent only three months out of each year at home for four years. If the adults in the neighborhood were truthful, the casings had been in use for three years. At the time of examination, she had been at home for

three weeks after nine month's absence.

The other 2 cases, Case 14 and 18, were infants three months old. Because of extensive use of large amounts of white lead cosmetics, the Japanese have probably had the largest experience with infantile lead poisoning. Kasahara<sup>12</sup> reports toxic symptoms appearing at about six months from ingestion of lead-containing breast milk. Toxicity from inhalation should develop

more promptly. Case 18 in this group developed gastrointestinal upsets in one month, Case 14 showed red blood cell stippling (2 per 5,000) when examined. No skeletal deposits were demonstrable. Apparently, even from lead inhalation, recognizable metaphyseal deposits will not appear until after more than three months of exposure.

2. In general, the younger the child, the more prominent were the skeletal deposits.

3. In this group, there was a surprising absence of gastrointestinal disturbance, which is usually a consistent and early occurrence in lead poisoning. The intelligence of these families was such that it seems probable that minor upsets had gone unnoticed.

4. There was no close correlation between the prominence of the skeletal deposits and appearance of toxic symptoms. The latter seemed to be largely a matter of individual idiosyncrasy, some children tolerating the poison better than others.

There was a definite history of toxicity in Cases 10 and 11, with only 2+ roentgen changes, while in all 5 cases showing 3+ changes, no history of toxicity could be discovered.

Of the 2 three months old infants, Case 14, probably exposed to larger amounts of lead and showing 1+ red blood cell stippling, was free of symptoms, while Case 18, with no stippling, had suffered from gastrointestinal symptoms for two months.

Case 7, the first patient, had suffered from a lead meningo-encephalopathy for seven months, with 4+ roentgen changes. Case 13, also with 4+ changes, showed a little widening of the sutures and gave a history of muscular pain on strenuous exercise for a year, but had suffered no convulsions.

5. There was a close correlation between the intensity of the lead sulphide stain on the teeth and the prominence of the roentgen changes. The two were graded by different examiners. The stains were confined almost entirely to the necks of the incisors, particularly the upper incisors. In this

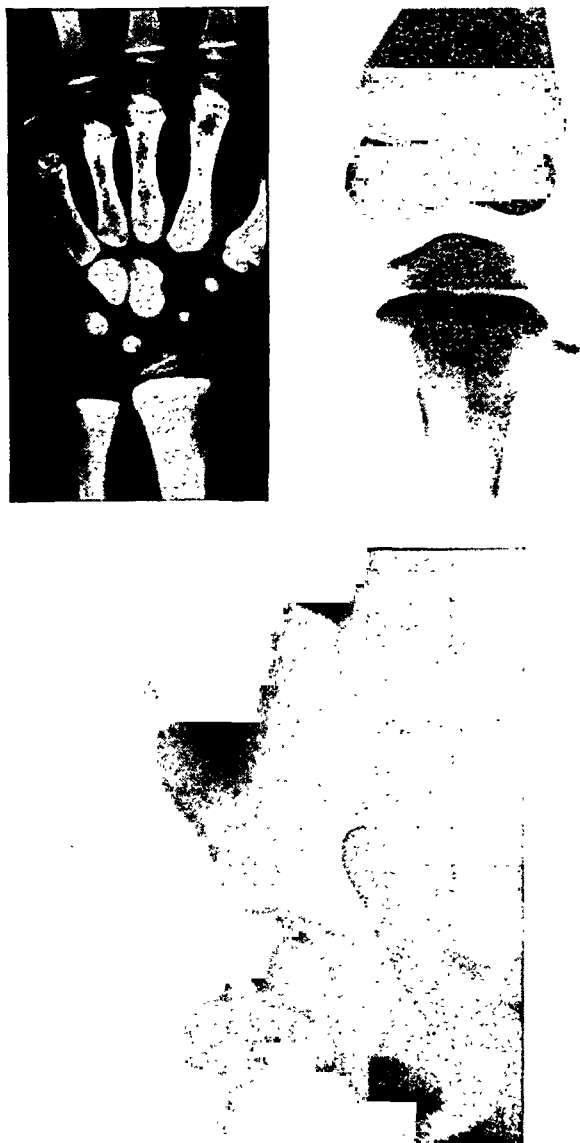


FIG. 4. Case 6. Three plus roentgen changes. Prominent metaphyseal densities and multiple fine, parallel diaphyseal densities.

group, the stains offered almost as accurate a diagnosis as did the metaphyseal density. Cases 3 and 9 showed 1+ roentgen changes with no dental deposits.

The teeth of Case 7 were roentgenographed but no abnormalities were demonstrable.

No lead lines were found in the gums of any of these patients.

Kasahara<sup>12</sup> reported that lead sulphide stains were found consistently in the necks of the teeth of poisoned Japanese nurslings.

6. Red blood cell stippling was of little

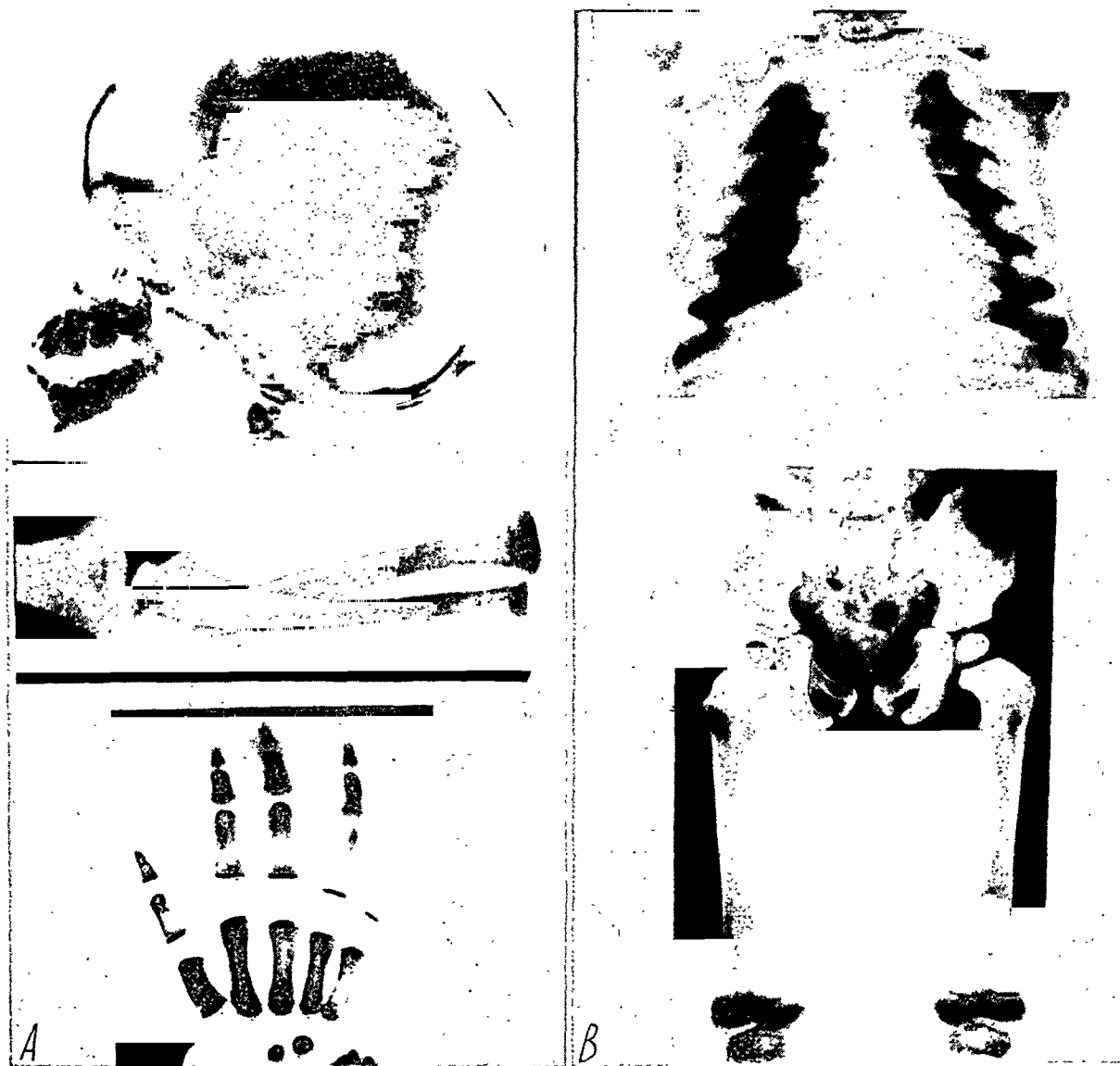


FIG. 5, *A* and *B*. Case 7. Four plus roentgen changes. Very prominent densities in all metaphyses with finer, parallel diaphyseal densities; peripheral density in carpal ossification centers, loosening of cranial sutures.

diagnostic assistance. Negative findings were of no significance.

7. Burning of battery casings was dangerous to neighbors as well as those in the home. The children in Houses 1 and 4 probably inhaled more lead out of doors in the smoke from their neighbors' stoves than in their own homes.

8. Chest roentgenograms of these patients showed no abnormalities in the lungs.

#### CONCLUSIONS

1. Until the disposal of discarded battery casings is regulated by law, outbreaks of

inhalation lead poisoning will continue to occur. In spite of the disagreeable odor of the burning casings, in times of economic distress and fuel shortage they will be used for fuel.

2. Whether absorption of lead is from the respiratory or gastrointestinal tracts, the roentgen changes are identical.

3. Roentgenographic evidence of skeletal deposits, even with daily absorption of abnormal amounts of lead, does not appear in less than three months from inhalation poisoning. The time should be longer in cases of lead ingestion—probably about six months. Toxicity may precede demon-

TABLE I

	Case No.	Sex	Age	Roentgen Changes	Lead Stains on Teeth	Red Blood Cell Stippling	Comments
House No. I. Used casings occasionally, about a month out of the year for several years	1	F	12 yr.	1+	1+	o	Latent and past history negative.
	2	M	10 yr.	1+	None	o	Latent and past history negative.
	3	F	4 yr.	2+	2+	o	Latent and past history negative.
House No. II. Used casings constantly for at least three years	4	M	10 yr.	2+	3+	o	Latent and past history negative.
	5	M	7 yr.	3+	3+	o	Latent and past history negative.
	6	F	4 yr.	3+	3+	2+	Latent and past history negative.
	7	M	18 mo.	4+	4+	4+	Original patient.
House No. III. Used casings constantly for at least three years	8	F	17 yr.	None	None	o	In school for deaf and dumb 9 months out of year for 4 years, home only for 3 summer months.
	9	F	14 yr.	1+	None	o	In school for deaf and dumb 9 months returned home 3 weeks previously. Latent and past history negative.
	10	M	12 yr.	2+	2+	o	For past 2 years frequent episodes nausea, vomiting and headaches.
	11	F	9 yr.	2+	2+	3+	For past 2 years frequent episodes nausea, vomiting and headaches. Cranial sutures a little wide.
	12	F	5 yr.	3+	3+	4+	Latent and past history negative.
	13	F	3 yr.	4+	3+	2+	For past year, when running, often stops, cries because legs ache. Cranial sutures a little wide.
	14	F	3 mo.	None		1+	No symptomatology.
House No. IV. Used casings very seldom, about one week two or three times in past three years	15	F	20 yr.	None	None	o	Boarder in home for 5 years.
	16	F	9 yr.	1+	1+	o	Latent and past history negative.
	17	F	3 yr.	3+	2+	o	Latent and past history negative.
House No. v. Refused examination							
House No. VI. Used casings occasionally, about a month out of each year for past three years	18	F	3 mo.	None			At 1 month began vomiting feedings; continues to do so; hungry and crying all the time. Father works at night, mother and baby spend nights in House III where casings used constantly.
House No. VII. Refused examination							
House No. VIII. Used casings frequently but not constantly during past winter months	19	F	4 yr.	3+	3+	o	Latent and past history negative.

A few of the older children in these households were not examined. A young child in one of the households which refused examination died of convulsions of unknown etiology during the period that the batteries were in use. The neighbors stated that the batteries were used constantly in these two households.

strable skeletal changes.

4. Gray or black stains on the necks of the teeth of children, especially the upper incisors, should arouse suspicion of lead poisoning.

5. In the presence of such stains, of evidence of increased intracranial pressure

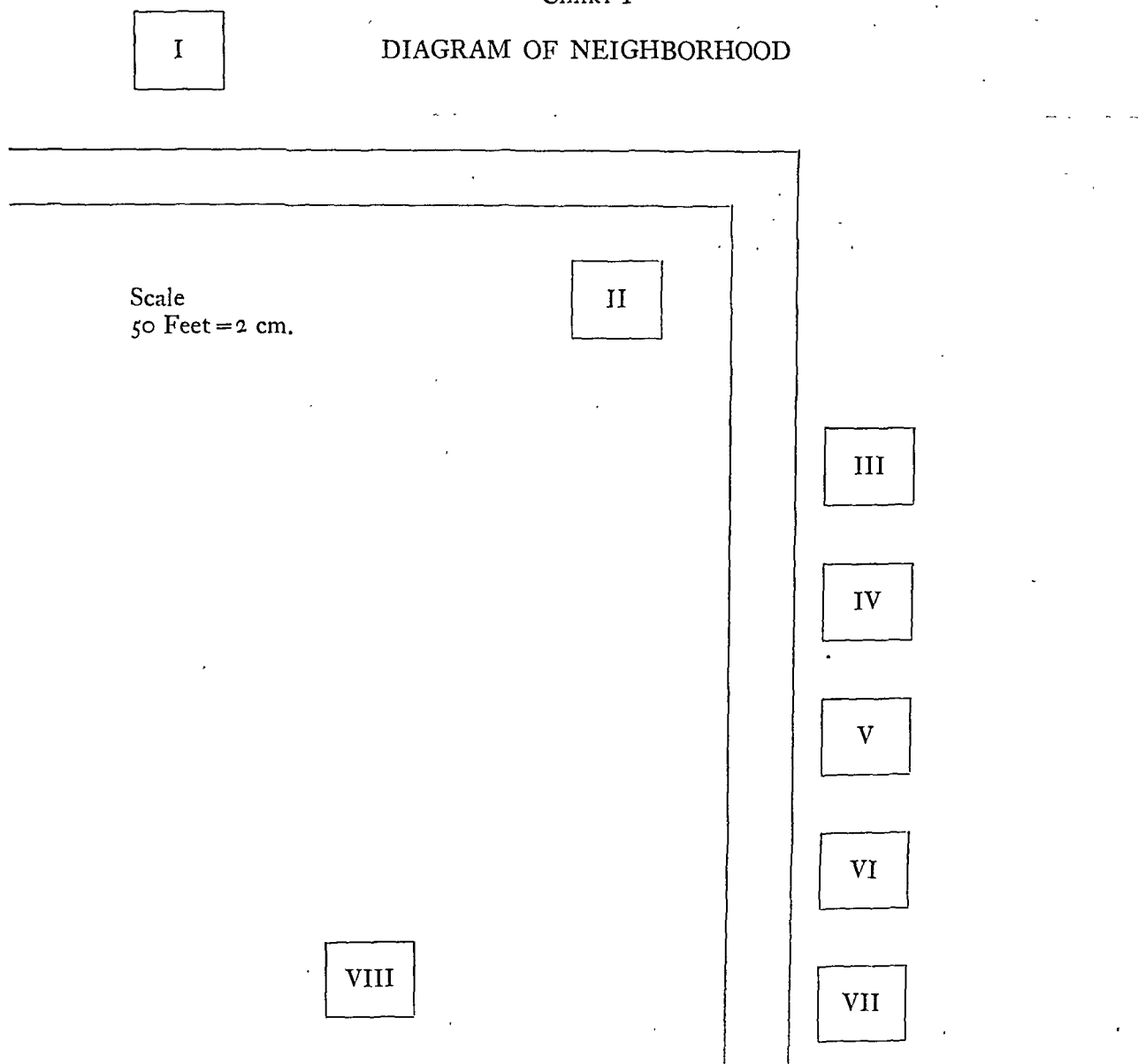
or meningeal irritation of uncertain etiology, of gastrointestinal disturbance of uncertain etiology, or of obscure muscular pains or weakness, the skeleton of children should be examined roentgenographically.

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## CHART I

## DIAGRAM OF NEIGHBORHOOD



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## SOFT TISSUE CHANGES IN EARLY ACUTE OSTEOMYELITIS\*

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THERE is such unanimity of opinion regarding the statement that in acute osteomyelitis there are no roentgen changes until the tenth to fourteenth day of the disease that it would appear unwise to offer any rebuttal; yet our experiences during the past few years are such that we feel justified in recording certain findings which are contrary to the usually accepted data.

During the routine roentgen studies of acute osteomyelitis the emphasis has always been on the bone lesions, so that other significant changes have received scant attention. These changes are manifest in the soft parts surrounding the involved bones and are at times present within a matter of hours after the onset of bone infection. The usual roentgenograms of the bone are of little value in determining the presence of soft tissue changes because the detail of the soft parts is most often obliterated. However, even roentgenograms made expressly for bone detail when viewed with a spotlight will frequently reveal evidences of soft tissue abnormalities.

The most consistent change in early active osteomyelitis is a roughening of the normally sharp line of demarcation between the subcutaneous shadow and the muscle bundles. Concomitant with this change is another important abnormality, namely, the tendency to obliteration of the intermuscular cleavage planes (Fig. 1). The usual normal subject will show a very clear-cut change roentgenographically at the muscle-subcutaneous line, but in acute osteomyelitis there is regularly present within twenty-four hours considerable distortion at this stripe, characterized chiefly by transverse irregular lines of increased density extending from the muscle borders into the subcutaneous shadows. These lines

are not particularly straight or regular in length or width, but seem to produce a crisscross pattern that suggests they may be vascular and lymphatic channels that have become patent or dilated. Apparently a similar change occurs in the usually clear-cut intermuscular planes that normally stand out as lines of decreased density, for in most cases of early acute osteomyelitis it is very difficult to separate the muscle compartments.

The changes described are obviously not of the same degree in every case and may actually vary both with the severity and the duration of the disease. Of special interest is that they may actually be evident in the roentgenogram even in the absence of clinical evidence of tissue swelling, although after the first forty-eight hours there is usually both clinical and roentgen evidence of enlargement of the soft parts. Perhaps the first roentgen changes are an expression of tissue edema that is subclinical.

The most important fact concerning the changes under discussion is their distribution in the tissues. All of our cases, which showed these early soft part abnormalities, revealed that they extended throughout the tissues along the length of the bone involved. In other words, when the upper end or any part of the femur was the seat of infection the soft parts along the entire length of the bone on the lateral, medial, anterior and posterior aspects reflected the changes (Fig. 1). The abnormality does not tend to pass beyond the joints unless the joints themselves are likewise involved.

When there is evidence of periosteal reaction with a break in the cortex the changes in the soft parts tend to regress (Fig. 2), but of course may be manifested

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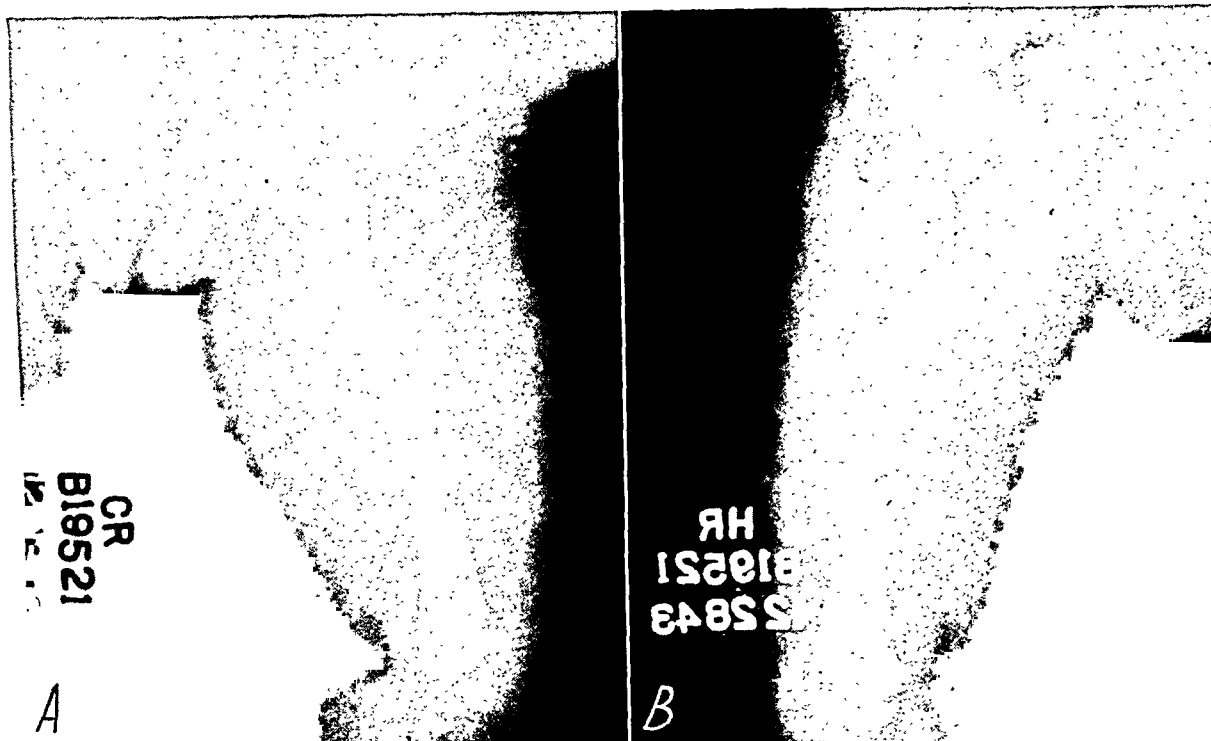


FIG. 1. *A*, soft tissue detail showing the irregular pattern in the subcutaneous tissues with obliteration of the musculosubcutaneous stripe and the intermuscular septa. Note the distribution throughout the soft parts. No bone changes. Forty-eight hours after onset of symptoms. *B*, subperiosteal calcification is now evident and the soft part changes have subsided greatly.

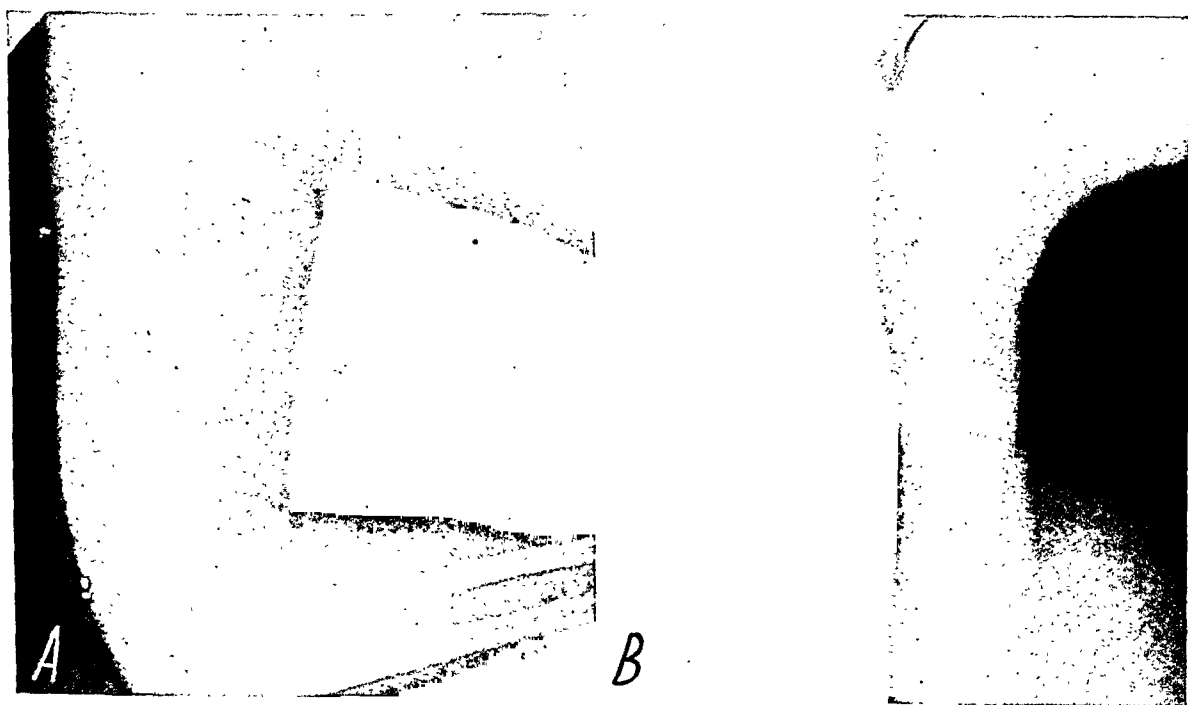


FIG. 2. *A*, soft tissue swelling and loss of tissue planes. No bone changes. *B*, normal soft tissue lines visible after there is obvious bone involvement.



FIG. 3. Soft tissue swelling over the lateral malleolus. Note the localization and absence of diffuse soft part changes. The musculoskeletal stripe is sharp except immediately above the local swelling.

in those cases which go on to the chronic stage.

In an effort to evaluate the significance of these tissue abnormalities we made studies of other conditions which might be expected to produce a similar picture. For this purpose we compared cases of acute osteomyelitis with acute sprains, soft part abscesses, tumors of both bone and soft tissues, blood dyscrasias with extravasation and edema of varied origins. In general, the main difference was the one of distribution and extent. A sprain shows localized swelling of the surrounding parts, with variable extension above and below of the crisscross pattern, but rarely an extension along the entire shaft of the bone (Fig. 3). Soft tissue abscesses do likewise (Fig. 4 and 5). Tumors also present a localized soft tissue density of varying size with but minimal extension of stroma changes that obliterate normal lines of demarcation (Fig. 6). Extravasation of blood or edema produces a picture indistinguishable in character from that seen in acute osteomyelitis, but usually the distribution is quite different in that the changes cross the joints and often extend along an entire extremity (Fig. 7).

The type of soft part change under discussion seems to have been signally ignored and very few references to it can be found. Ferguson<sup>4</sup> in his monograph on bone diseases describes them, but such recent books as those by Caffey,<sup>3</sup> Archer,<sup>1</sup> and Brailsford<sup>2</sup> fail even to mention them and in fact stress the point that in early acute osteomyelitis there are no roentgen changes under ten to fourteen days.

The fact that soft tissue changes are manifested early raises an important point concerning the proper manner of studying each suspected case. In our opinion the part in question must be studied both for bone and soft part detail. Only in this way will the important early alterations be recognized. For a complete study we feel it is wise to roentgenograph the corresponding normal part in the same manner so that the known normal tissues can be used for comparison. The time and effort spent will often be well rewarded.

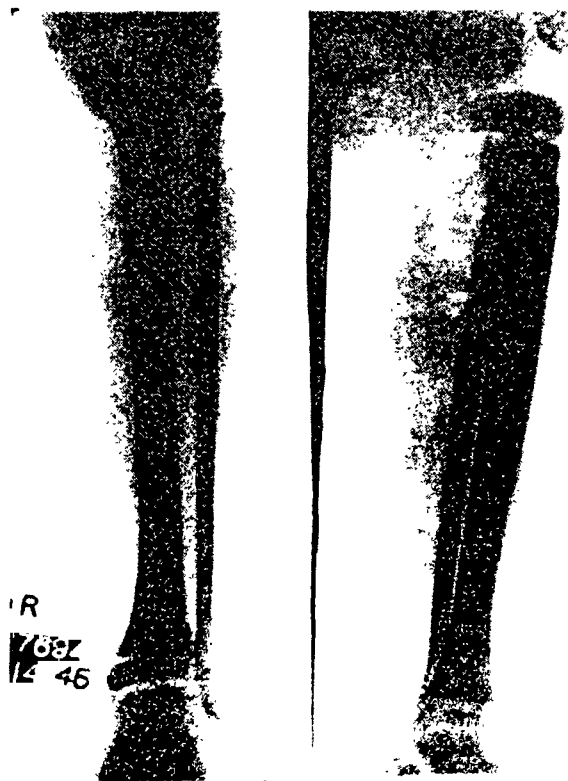


FIG. 4. This demonstrates a soft tissue abscess at lower anteromedial aspect of the leg. The swelling is localized and there is no diffuse soft tissue abnormality.

The chief factor concerned in the production of the soft tissue changes described is perhaps the increase of pressure within the marrow cavity incident to infection. This rise in pressure is transmitted throughout the rigidly confined space to the haversian systems and thence to the surrounding tissues. As a result, there is apparently some mechanical effect on both the vascular and lymphatic systems which leads to the dilatation of vessels and the opening of many otherwise only potentially patent channels. Along with this alteration in the vascular and lymphatic pattern, there is some edema of the muscles and the surrounding stroma. Both of these factors may play a significant role in producing the roentgen picture. The degree of change is very likely proportional to the extent and severity of the initial infection. Another possible explanation is that the toxic products of infection induce the local soft tissue abnormalities.

That an increase in intra-osseous pres-

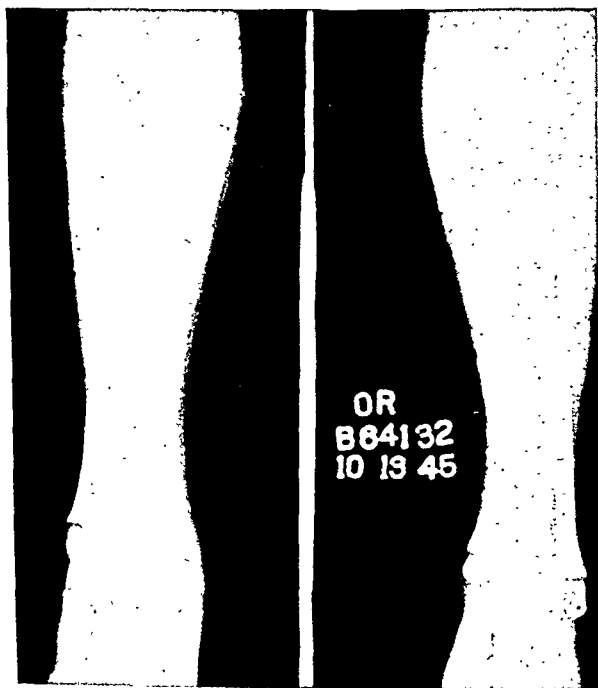


FIG. 5. A comparison of left and right legs, showing a soft part abscess above the medial aspect of the left ankle. Note the criss-cross pattern at the abscess site; the change is not widespread. Right side normal.



FIG. 6. A soft tissue roentgenogram showing a localized mass in patient with osteogenic sarcoma. There are no widespread tissue changes.

sure occurs in osteomyelitis was shown by Hedri<sup>5</sup> in experiments designed to determine why cases of acute bone infection manifest a definite lipuria early in the disease. He concluded that when the pressures in the shaft rose above a certain height the fat in the marrow was actually forced into the veins, thus eventually reaching the urine. He states that the test for fat in the urine is extremely helpful in the early diagnosis of acute osteomyelitis. Of interest in this work is the finding that if the infection escapes from the marrow cavity into the subperiosteal space, then lipuria is not usually found. This would seem to coincide with our observation that the soft tissue changes as seen in the roentgenograms tend to regress when there is evidence of periosteal elevation or a cortical break and perhaps indicates that the release of the high intra-osseous pressure is responsible for the disappearance of lipuria as well as the soft tissue abnormalities.

Ferguson<sup>4</sup> states that perhaps the earliest change in acute osteomyelitis is the

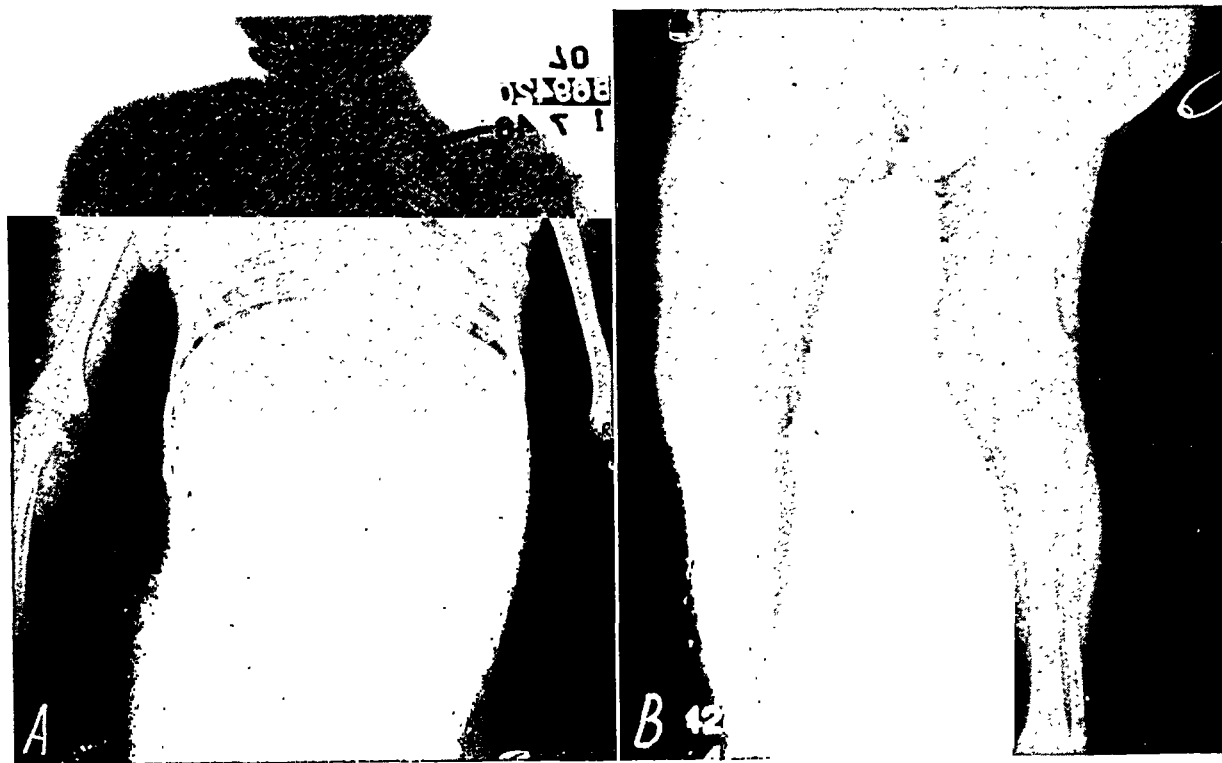


FIG. 7, *A* and *B*. Roentgenograms showing widespread soft tissue changes in a child with a blood dyscrasia. Changes were due to extravasation of blood into the soft tissue of right arm and shoulder and the lower extremities.

one that occurs within the bone itself and produces a localized abnormality at the site of the infection. The presence of infection in bone results in inflammation of the soft parts of the marrow cavity so that a local obliteration of trabeculae takes place producing a picture of haziness at the site of the lesion. We have ourselves observed this particular finding but caution that it is extremely difficult to evaluate and very often impossible to demonstrate unequivocally on the roentgenograms. This type of change does not lend itself well to reproduction, so that we have not attempted any illustrations showing it.

To say that every case of acute osteomyelitis will show early soft tissue change would be unjustified. Moreover, to state that the changes when present are pathognomonic would be presumptuous, yet we feel strongly that if each suspected case of acute osteomyelitis is studied thoroughly and properly the roentgen pattern will often be of invaluable aid in arriving at the correct diagnosis.

The changes discussed have been mani-

fested primarily in children, yet on several occasions they have been noted in adults. The soft parts in children can be demonstrated more easily than in the adult, but if the proper technique is employed there is usually little difficulty in securing roentgenograms of satisfactory detail. However, it must be stressed that unless the soft parts are specifically studied the changes are apt to be completely overlooked.

#### CONCLUSIONS

1. The soft tissues surrounding the involved bone in acute osteomyelitis frequently show characteristic roentgenographic changes.

2. The changes are manifested as lines of increased density in the subcutaneous tissues, loss of the sharply demarcated subcutaneous muscular stripe, and loss of the usual intermuscular shadows.

3. The soft part changes are manifested early in the disease, sometimes appearing within twenty-four hours after the onset of symptoms.

4. Each case of suspected osteomyelitis should have bone and soft tissue roentgen studies.

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# ROENTGEN EVALUATION OF LESIONS OF THE CARPUS\*

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**D**URING the past three years the number of roentgen examinations of the wrist at the Percy Jones General Hospital has shown a gradual upward trend. In 1943 an average of 14.4 were examined each month. During 1944 an average of 21.5 were examined, and in 1945 an average of 33.1 were seen. Since many interesting lesions have been observed, it was decided to present some of them in this paper.

Our experience with wrist injuries indicates carpal fractures in soldiers are more frequent than those of the distal radius. This is mainly because our patients fall in the younger group (twenty to forty years), when fractures of the navicular are most common. With well developed forearm musculature, as most often is the case in soldiers, a fall on the heel of the hand does not force the wrist into extreme hyperextension, but only partial hyperextension, so that the radius remains intact while the navicular bears the brunt of the force. The predominance of navicular over Colles' fractures in military life has been recently noted by Oblatz,<sup>21</sup> and by Finn and Palmberg.<sup>6</sup>

## ROENTGEN TECHNIQUE

Before considering the anatomy of the carpus and the roentgen findings in lesions of the wrist, a brief description of the roentgen technique employed at the Percy Jones General Hospital in examination of extremities will be described. This technique employs the Morgan-Hodges phototimer used in combination with a cardboard folder and Bucky device. The use of the Morgan meter in this department has been previously described.<sup>1</sup> This meter takes advantage of the fact that all properly exposed roentgen films are of an average density of 0.9 in the diagnostic range, as

read on a densitometer. This is true regardless of the part examined. The Morgan-Hodges phototimer performs the entire procedure in one exposure, embodying the advantages of the meter but avoiding the double exposure necessary with it. The operation of the phototimer is best explained by referring to Figure 1A. It will be seen that the phototimer consists of a phototube, *P*, and a small segment of fluorescent screen. As recently pointed out by Morgan,<sup>16,18</sup> the phototube-screen assembly is mounted below the Bucky tray of the roentgenographic table and is connected to a condenser-thyratron-relay system, indicated respectively by the letters *C*, *T* and *Re*. With closure of the switch, *Sw*, the roentgen tube at *A* is energized. The beam of rays now passes through the part to be examined, *B*, striking the film, *F*, and impinging almost immediately on the phototube-screen assembly. As the film is exposed, a small current reaches the phototube and collects on *C*, the condenser. When the voltage in this condenser reaches a certain predetermined critical level, the thyratron, or gas-filled triode tube, fires, energizing the relay, *Re*, thus terminating the roentgen exposure.

Recent publications of the University of Chicago group<sup>9,17,18,19</sup> have shown us that the amount of current flowing in the phototube is directly proportional to the intensity or brightness of the roentgen beam. Thus, when the thickness of the part is great, the phototube current is small and the exposure time relatively long. On the other hand, when the thickness of the part is small the brightness or intensity of the roentgen-ray beam falling on the phototube is correspondingly increased, so that the phototube current is high and the exposure time relatively short. It thus appears that

\* From Percy Jones General Hospital, Battle Creek, Michigan.

"... the reaction of the phototimer is identical to that of radiographic film, and all that is necessary to insure optimally exposed roentgenograms is to adjust the

grid. Examples of the variation in time of exposure as determined automatically by the phototimer in relation to the thickness of the part examined, are shown in Figure 1B.

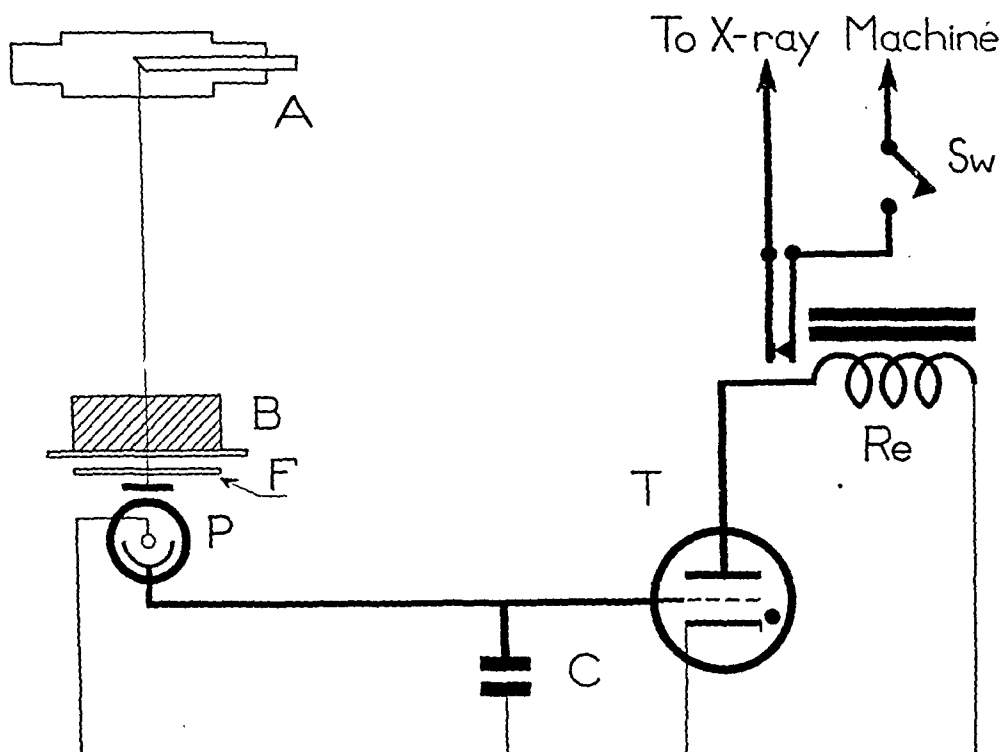


FIG. 1A. A, roentgen tube; B, part examined; C, condenser; F, film; T, thyatron; P, phototube; C, T, Re, condenser-thyatron-relay system; SW, switch. See text for explanation.

### EXTREMITIES WITH MORGAN & HODGES PHOTOTIMER

CM. THICKNESS	1	2	3	4	5	6	7	8	9	10
SECONDS	1/4	3/4	1 1/4	1 1/2	3 1/2	2 1/2	3 3/4	5 3/4	6	6 1/2
K. V. P.	65	65	65	65	65	75	75	75	75	75

### 30 MA. CARD BOARD 36 in. DIST. BUCKY TECHNIQUE

FIG. 1B. See text for explanation.

sensitivity of the phototimer to the sensitivity of the x-ray film" (personal communication, Morgan). We have found the Morgan-Hodges phototimer practically fool-proof as far as examination of the carpus is concerned, and recommend its use with par-speed films and the Bucky

#### ANATOMY OF THE CARPUS

There are eight carpal bones arranged in proximal and distal rows, making up a quadrangular carpal mass (Fig. 2). According to Terry,<sup>27</sup> this mass is wider below than above, and concave on its volar sur-

face. This concavity is increased by prominences on the radial and ulnar margins, and stretched transversely between these (like the string of a bow) is the transverse carpal ligament, thus forming the carpal canal for passage of the flexor tendons and median nerve into the palm of the hand. At birth the entire carpus is cartilaginous, each bone developing from a single ossification center. Two sets of nomenclature are in common use. According to one sys-

bones are called the greater and lesser multangulars, the capitate and hamate.

It is interesting to compare the carpus of amphibia to that of man (Fig. 3). As noted by Grant,<sup>7</sup> the bones of the hand

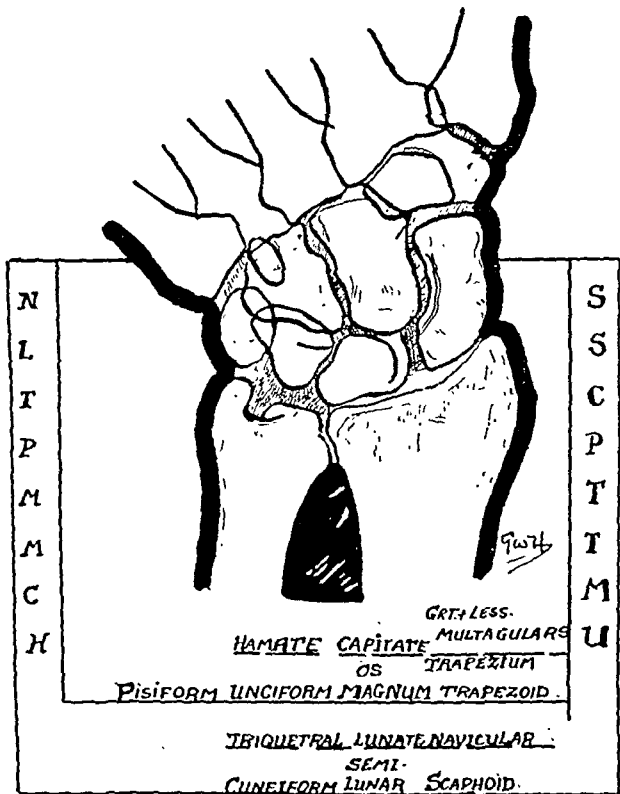


FIG. 2. The two sets of nomenclature of the carpal bones. The letters on the sides of the drawing represent the first letter of each of the corresponding carpal bones.

tem (I.N.A.),\* the proximal bones consist of the scaphoid, semilunar, cuneiform and pisiform bones, while the other system (B.N.A.)† names these bones the navicular, the lunate, the triquetral and pisiform. The distal bones, according to the first of the above nomenclatures, consist of trapezium, trapezoid, os magnum and unciform; while in the second group the

\* Jena Nomina Anatomica.

† Basle Nomina Anatomica.

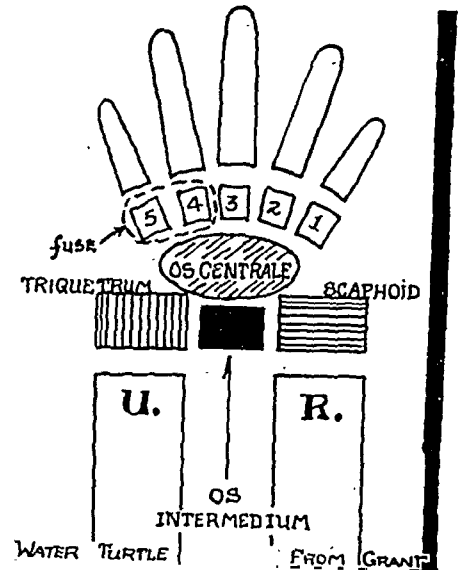


FIG. 3. Diagrammatic sketch showing similarity of carpus of amphibia and man. (Courtesy of Williams & Wilkins Co. Modified from illustration from "Method of Anatomy" by J. C. B. Grant.) Note that the os intermedium becomes the lunate and the fourth and fifth distal carpal bones fuse to form the hamate.

and wrist of man when compared with those of the water turtle are seen to possess a similar generalized plan. Three proximal carpal and five distal carpal bones are present in the turtle. The lunate arises from the os intermedium. The fusion of the

fourth and fifth distal bones gives rise to the hamate. The os centrale (there is usually one os centrale in primates, but several in the turtle) fuses with the dorsum of the scaphoid. One of the ossa centralia may well give rise to the pisiform, however it has been also suggested that this bone is a sesamoid that arises in the tendon of the flexor carpi ulnaris.

The navicular bone is located in the extreme radial position of the proximal row. It has ligamentous attachments to the lunate and capitate and is situated across the plane of the mid-carpal joint in such fashion as to take much of the strain and stress transmitted through this joint. Its blood supply is by way of ligamentous attachments. Since most of the bone (approximately three-fifths) is intra-articular and covered with cartilage, there is little room for attachment of ligaments. There is but one artery entering the tuberosity of the navicular, one or more enter the body through the dorsal carpal ligament. A narrow ridge runs obliquely around the dorsal surface of the navicular from the tuberosity on the lateral side to the proximal base medially. In this ridge are the foramina through which the blood vessels enter and leave.<sup>21</sup> Oblatz and Halbshtein,<sup>22</sup> studying 297 cadavers, found that there was considerable variation of the nutrient vessels: In 13 per cent there was no arterial foramen proximal to the mid-waist, in 20 per cent there was only a single small foramen at the waist or proximal to it, and in 67 per cent, two or more foramina were located proximal to the mid-waist.

#### FRACTURES OF THE NAVICULAR

The most common fracture of the navicular occurs at the waist, the next in frequency is in the proximal third and the last in the distal portion of the bone, or tubercle. In examining the navicular, in addition to dorsopalmar and lateral views, special views including oblique projections are often essential to place in profile the site of fracture. Often the fracture line may not be visible at first and may require

up to three weeks before becoming roentgenographically apparent. Therefore, the diagnosis of "sprain" must be made cautiously, even in the absence of positive roentgen findings.

Absorption or rarefying osteitis occurs at the fracture site in from several days to three weeks, making the fracture line prominent. Factors contributing to the absorption are said to be a change of pH to below the normal 7.4 and reactionary hyperemia about the fracture cleft.<sup>21,26</sup> Immobilization causes further demineralization both at the fracture site and generally wherever the blood supply is good. When a fragment retains its normal calcium content appearing radiodense, it may be assumed that its nutrition is impaired. Such a roentgen appearance, Oblatz states, suggests either a temporary avascularity or an aseptic necrosis.<sup>21</sup> In the former, fibrous granulations grow across the fracture line, bringing along new vessels. Healing takes place gradually in this manner, since there is a complete or almost complete lack of periosteal callus. The fragment may remain quite dense for months and yet become revascularized and subsequently revitalized. In the second instance, as often occurs when there is improper immobilization, a shearing movement of the fragments cuts the granulations. Fibrous tissue develops between the fragments, the bone margins become sclerotic and non-union ensues. Further changes may then occur in the form of aseptic necrosis, with creeping substitution by fibrous connective tissue and partial collapse of the bone. Arthritic changes invariably follow. Malalignment, angulation, or separation of the fragments are causes bound to contribute to non-union.<sup>5</sup>

Of 16 unselected fractures of the navicular from our files (Fig. 4), there were 8 fractures of the waist (50 per cent), 6 fractures of the proximal third of the bone (37.5 per cent), and 2 fractures of the distal third of the bone (12.5 per cent). These percentages indicate approximately the proportions of the types of navicular

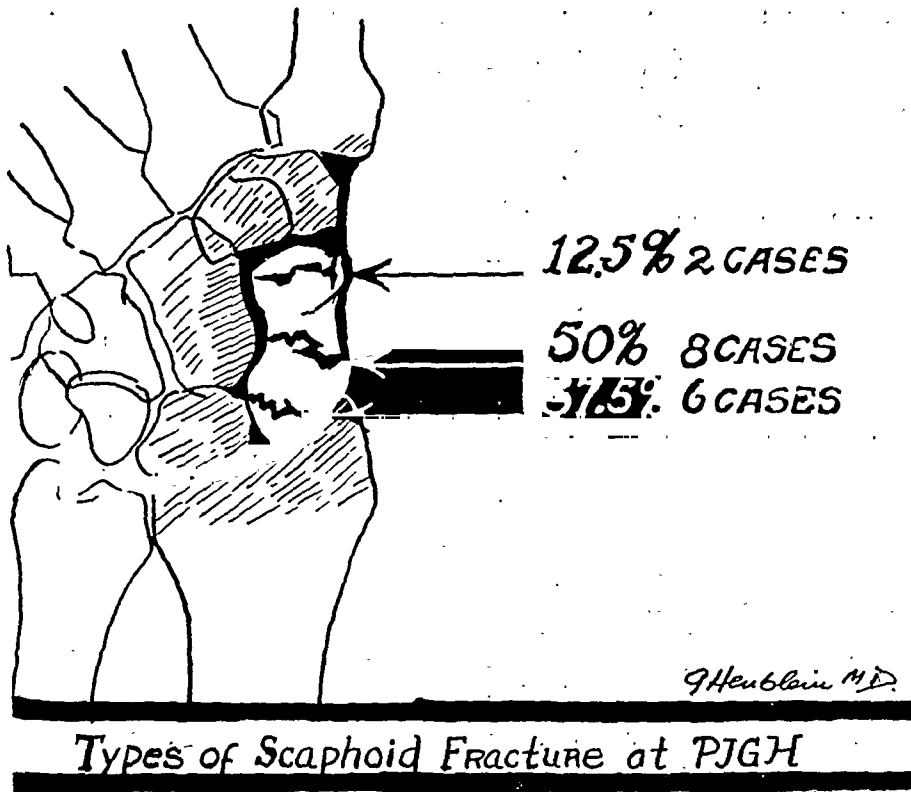


FIG. 4. Although the number of navicular fractures represented here is quite small, nevertheless these percentages indicate approximately the proportions of the many more navicular fractures that have passed through this hospital.

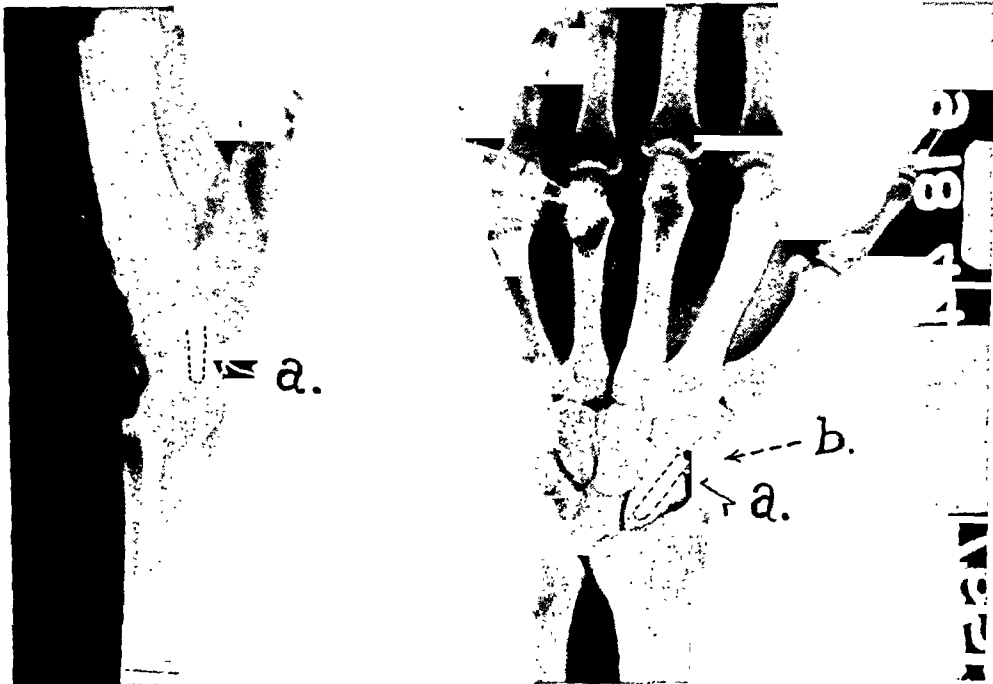


FIG. 5. Non-union of the fractured navicular treated by means of bone peg operation. This operation resulted in successful bone union of the fractured scaphoid after immobilization had resulted in non-union. *a* designates the bone peg. Several amorphous densities are observed in the soft tissues at *b*. These are tiny bone chips resulting from the operative procedure.

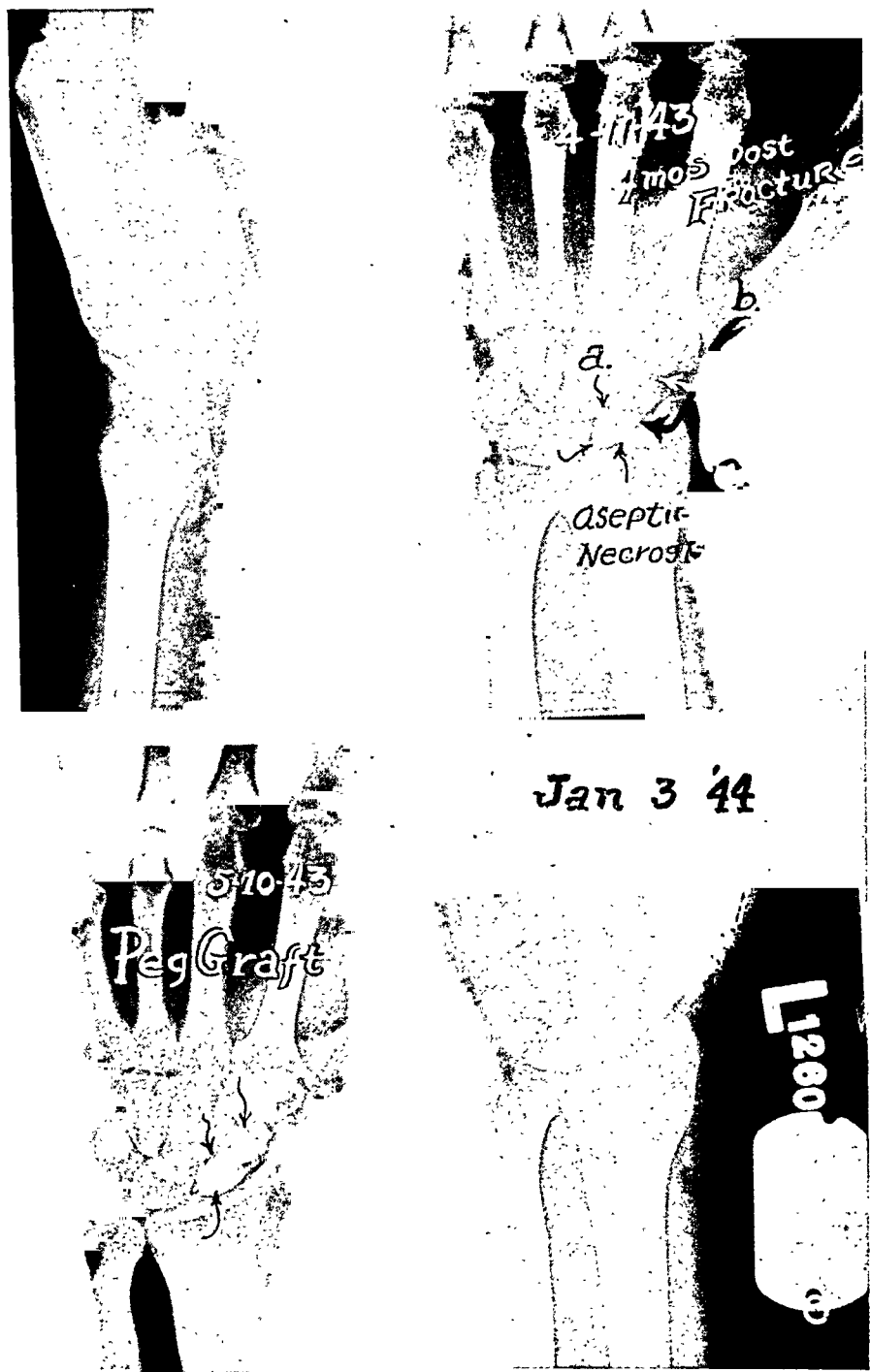


FIG. 6. This illustration demonstrates successful treatment of the fractured navicular by the bone pegging operation. As noted above at *a* the proximal fragment of the navicular shows evidence of poor nutrition. This navicular fracture resulted in non-union when treated by immobilization. The fracture line is indicated at *b*. Black arrows point to the bone peg. Note that revascularization of the proximal fragment of the navicular bone has taken place. This injury was incurred when the patient, while performing his detail of breaking in horses in Guadalcanal, was thrown from horseback into a foxhole on his outstretched hands. This resulted in a fracture of the navicular as shown. The injury occurred on January 7, 1943. Peg graft operation was performed April 12, 1943.

fractures as found in this hospital. Two of the waist fractures were associated with other injuries of the wrist. The other 6 fractures were injuries of the navicular

only. Treatment by immobilization usually resulted in satisfactory healing. In several cases of non-union, already established, bone pegging was found to be a successful form of treatment (Fig. 5 and 6). Arthritic changes developed in one of the fractures that showed healing by immobilization. There was also an increased density of the proximal fragment of this fracture. Another developed bone condensation changes of

anteroposterior lengthening and in time a proximal-distal flattening may occur. This type of fracture generally occurs from a fall on the dorsiflexed hand, but occasionally with the hand in forward flexion. It occurs when the direction of force is such that the navicular escapes and the lunate is squeezed between the capitate and radius.<sup>2</sup> Three cases of fractured lunate have been encountered. One was a fracture

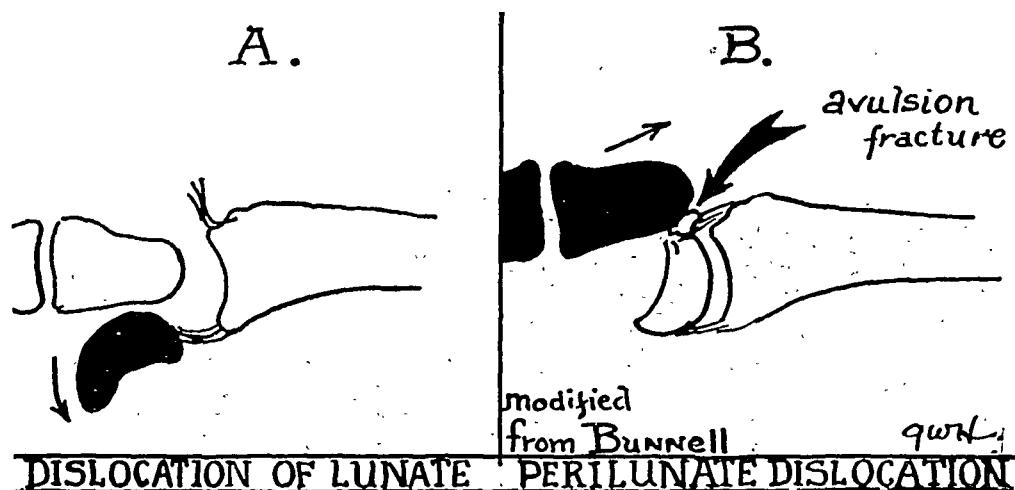


FIG. 7. Two most common types of dislocations of the lunate. (Courtesy of J. B. Lippincott Co. Modified from Bunnell, "Surgery of the Hand.")

the proximal third of the navicular even though the fracture line was situated more distally near the center of the bone.

#### FRACTURES OF THE LUNATE

Fractures of the lunate are quite rare. Occasionally a chip fracture of the dorsal tip of the lunate occurs with a dorsal perilunar type of dislocation of the carpus (Fig. 7B).<sup>3</sup>

In the past it has been suggested that separate fragments of bone in this region are accessory ossicles, termed the "epilunate" and "hypolunate." We feel, as Kienböck<sup>12</sup> originally maintained, that these actually represent small avulsion fractures.

The more usual type of isolated fracture of the lunate occurs in the mid-portion of the bone from the concave to the convex surface. In this case the deformity is best seen in the lateral projection. It presents

through the superior third of the bone caused by gunshot wound. Healing occurred with no deformity and without evidence of degenerative changes. Another fracture through the center of the lunate was associated with fracture of the triquetral and pisiform (Fig. 18, c). The third will be discussed with dislocations of the lunate.

#### DISLOCATIONS OF THE LUNATE

Dislocations of the lunate are of two main types (Fig. 7). The first is a luxation of the lunate itself, usually volarward with rotation of the lunate from 90 to 270 degrees.<sup>13</sup> Occasionally dorsal dislocation occurs. In some instances the lunate carries the proximal half of the fractured scaphoid with it, or even the whole scaphoid bone. The second type is not a true dislocation of the lunate, but rather a perilunar dislocation of the carpus. In this lesion the

distal carpal row rides backwards and upwards. There is often a chip fracture of the dorsal tip of the lunate, of the styloid of the radius or ulna, or a fracture of the navicular. When an associated fracture of the navicular occurs, the proximal fragment usually remains with the lunate, the distal fragment displacing with the distal carpus. The triquetrum is also usually dislocated. When the latter is fixed by the end of the ulna with the hand in ulnar deviation, the triquetrum remains in place and the navicular is dislocated with the distal carpus.

We have had 3 cases of dislocation of the

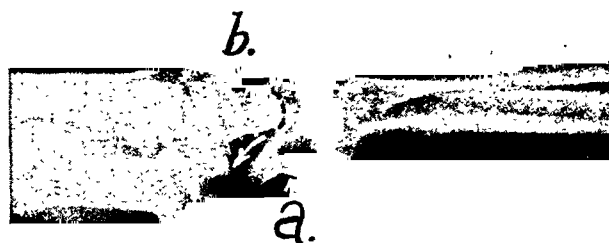


FIG. 8A. Simple volar dislocation of the lunate bone. The lunate is rotated 90 degrees and indicated by *a*. Note the head of the os magnum at *b*, which is in proper alignment with the head of the radius. The central arrow indicates the direction of rotation.

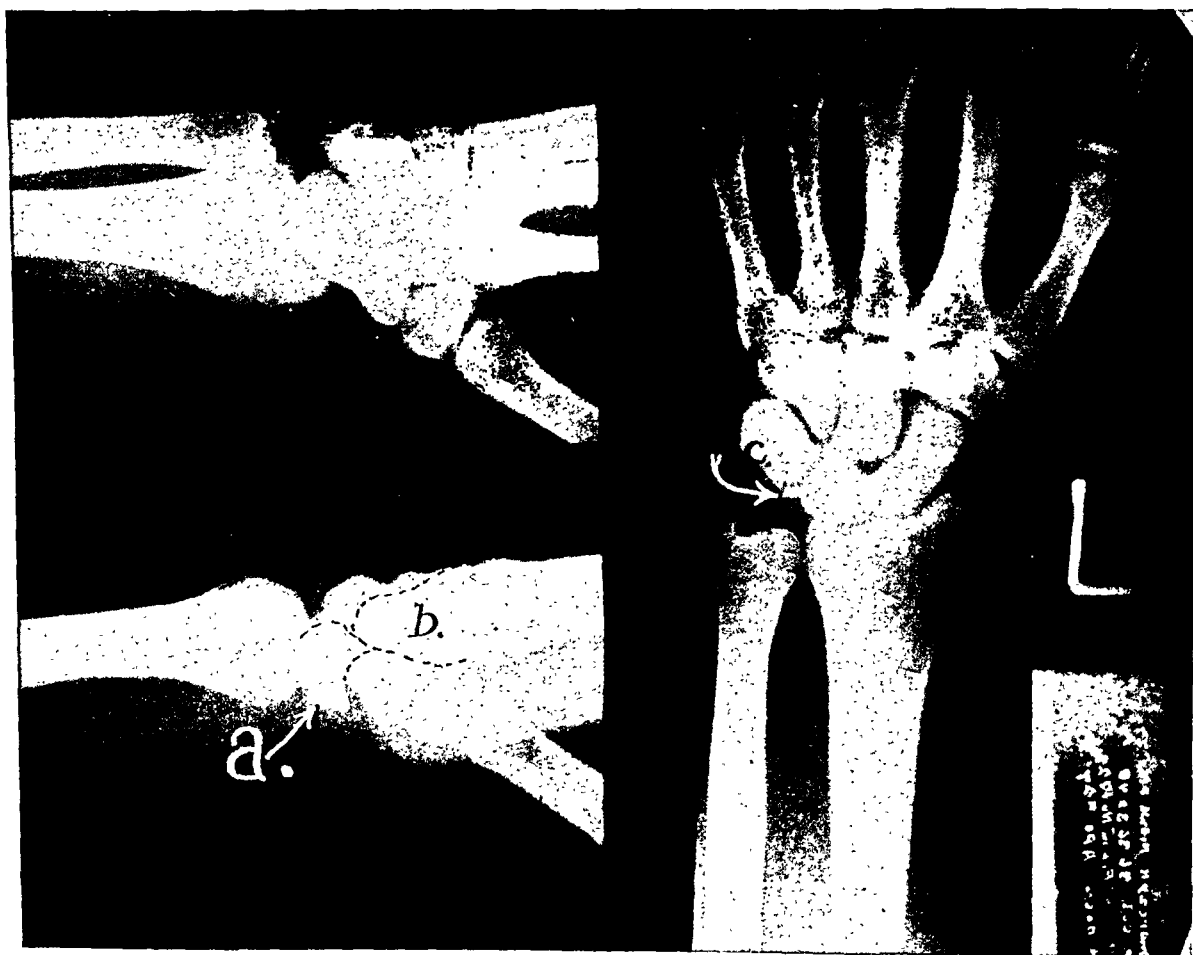


FIG. 8B. Perilunate dislocation of the carpus with chip fracture of dorsal tip of lunate. This twenty year old private, on September 20, 1943, while negotiating an obstacle course fell from a rope on his outstretched left hand. A painful swollen wrist resulted. On October 16, 1943, the semilunar was removed overseas and the dislocation reduced. The wrist remained painful due to slight rotation of the scaphoid. He was transferred to Percy Jones General Hospital where physiotherapy was prescribed. He was discharged improved, with but moderate residual limitation of motion. There was 50 per cent limitation of supination, 50/70 restriction of palmar motion and 40/60 of dorsiflexion. The lunate bone is indicated by *a*; the capitate at *b*. A chip fracture of the dorsal tip of the lunate is observed at *c*.



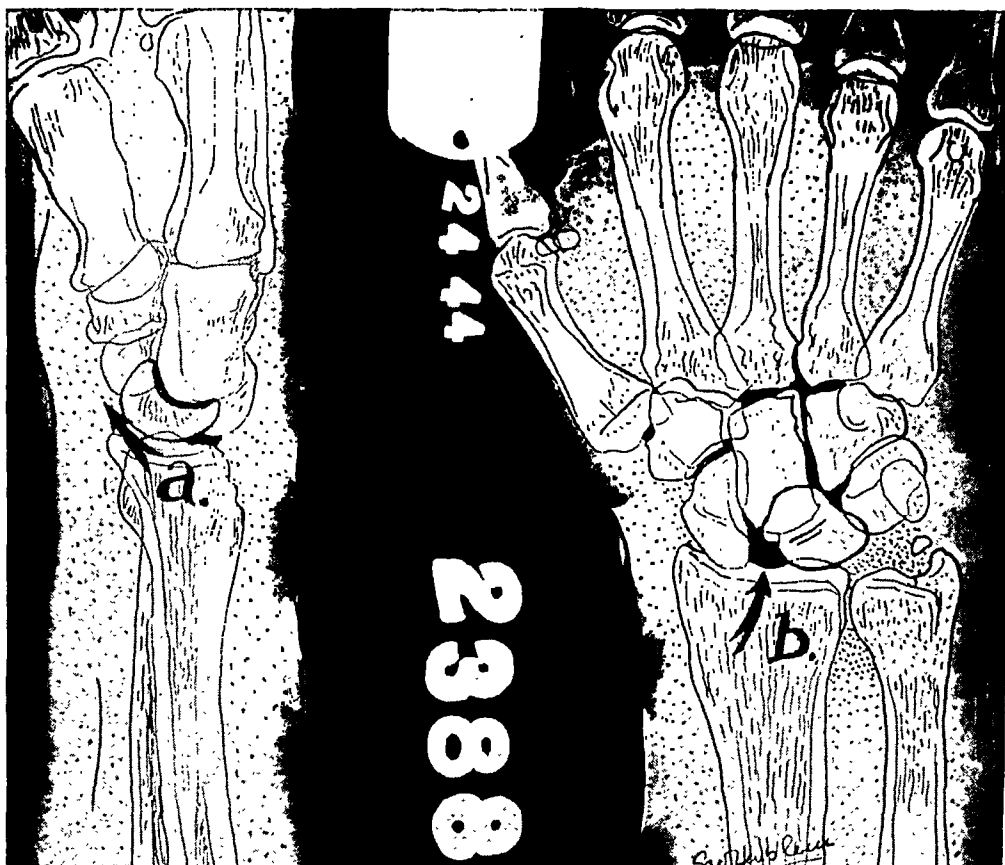
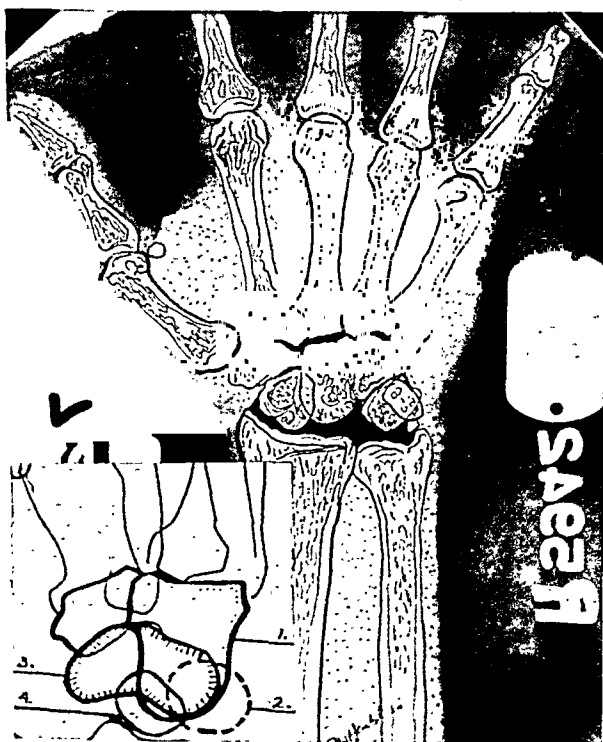


FIG. 9. Partial subluxation of the semilunar. This injury was incurred in December, 1943, while the patient participated in authorized athletics. The wrist was treated as a "sprain." Because of continued complaints he was referred to this hospital and subsequent roentgenograms showed the partial volar (*a*) and ulnar (*b*) subluxation of the lunate as seen above. In March, 1944, the lunate was removed.



lunate. One is a simple volar luxation of the lunate itself (Fig. 8*A*). Another is a perilunate dislocation of the distal carpus, with a chip fracture of the dorsal aspect of the lunate (Fig. 8*B*), which was treated by removal of the semilunar with a satisfactory end result. The third case (Fig. 9) is a volar and ulnar subluxation of the lunate with widening of the navicular-lunate joint space. This was treated by removal

FIG. 10. When the lunate in Figure 9 was removed, the navicular was sutured to the capitate in an attempt to stabilize the wrist. However, the suture failed to hold and the changes seen above occurred. The navicular rotated so that the radial side was depressed and the ulnar half elevated. The head of the capitate moved proximally toward the radius. The drawing of the wrist in lateral projection (insert) shows well why the navicular appears foreshortened in the dorsopalmar view. 1, os magnum; 2, triquetrum; 3, navicular; 4, pisiform.

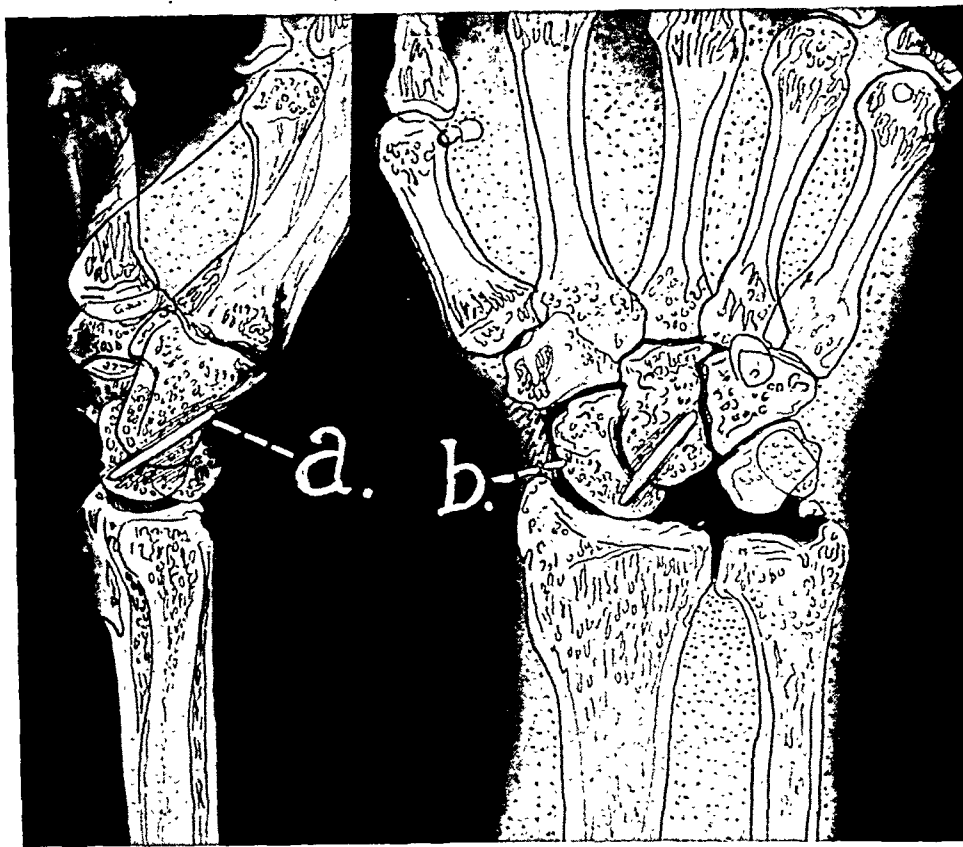


FIG. 11A. In this figure a method of stabilizing the wrist following removal of the lunate is demonstrated. The scaphoid is pinioned in normal position by passing a Kirschner wire proximally through the capitate and into the scaphoid. The patient was discharged to limited duty. This is the same case shown in Figures 9 and 10. *a* indicates the Kirschner wire. The navicular, in normal position, is shown at *b*. Compare with Figure 10. The foreshortening of the navicular has been corrected.

of the semilunar. Later, because the head of the capitate began to move proximally with undesirable rotation of the navicular (Fig. 10), the wrist was stabilized by transfixion of the navicular and the capitate with a metal pin (Fig. 11). This procedure, advocated by McKeever,<sup>15</sup> has, in our opinion, proved to be most successful.

FIG. 11B. Drawing to show operative approach to carpus through dorsal longitudinal incision. *r*, radius; *n*, navicular; *c*, capitate. Upper illustration shows abnormal dynamics of wrist due to dorsal rotation of the navicular, which occurred as the result of previous removal of the lunate. Flexion of the wrist is interfered with. Lower illustration shows method of inserting fixation pins through capitate after navicular is pushed back into normal position by means of a small curette, shown at *a*. Following arthrodesis, normal flexion of the wrist

#### KIENBÖCK'S DISEASE

Another carpal lesion occasionally seen is Kienböck's semilunar malacia. Since his



can be demonstrated. Compare foreshortened navicular, *n*, with more normal position at *n'*. Procedure advocated by McKeever.

G.H.

first report<sup>12</sup> in 1910, considerable controversy has taken place over the pathogenesis of "semilunar malacia" and the so-called similar disease of the navicular reported by Preiser.<sup>23</sup> Interference with blood supply has repeatedly been submitted as the main cause of this condition, this in turn brought about by repeated minor traumas or a single severe injury. Often enough, however, no definite history of trauma is elicited. According to Bunnell<sup>3</sup> increased pressure changes occur within the lunate and navicular in much the same manner as increased intracranial pressure. The reason given is that the proportion of the non-articular surface is relatively small, so that there are few foramina for incoming vessels, the bone being closely invested by cartilage. Increased pressure from edema within the bone thus easily cuts off the blood supply reducing nutrition to the point where patchy necrosis results. This is followed by creeping substitution by highly vascular granulations which produce the lucid cyst-like areas seen in the roentgenogram. The question has often been asked: "Is the fracture line primary or secondary?" We feel that it is usually the immediate result of the original compressing force; however, the fracture line is commonly quite fine, otherwise increased pressure could not be built up within the bone. Mouat, Wilkie and Harding<sup>20</sup> watched the progress of deformity of the lunate, following the fractured bone by repeated roentgenograms. Later histological examinations showed progressive degeneration with absorption of necrotic bone and fibrous tissue replacement. One factor favoring fracture and the fracture-first theory is the presence of a large nutrient foramen on the radial surface of the lunate, as described by Boyd.<sup>2</sup> This foramen expands into a depression probably hollowed out for the attachment of a ligament. Very deep in some cases, this foramen may prove to be a source of weakness. Kienböck's disease does not, however, develop as originally maintained by Kienböck following "mo-

mentary dorsal luxation of the hand with volar subluxation of the lunate." This contention has been repeatedly disproved in recent years.<sup>4,24</sup> Although similar roentgen changes have been described in both the lunate and navicular,<sup>13</sup> we have encountered no cases of malacia of the navicular bone. One wonders whether the line of decreased density described by Preiser,<sup>23</sup> appearing eight or nine days after injury, is not merely a delayed appearance of a fracture line, since he does not speak of generalized changes in density or changes in the shape of the navicular.

Roentgenograms of wrists affected by Kienböck's disease ordinarily reveal mottled areas of increased density with intervening cystic areas in the lunate bone. Such findings indicate a process of softening. The lunate subsequently loses its characteristic shape. One of us (G.W.H.) has noted a helpful roentgen finding in this disease entity, namely, the dorsal pole of the lunate becomes flattened and projects over the head of the os magnum in tongue-like fashion, as is demonstrated in Figure 12. In the absence of marked bone condensation change, this roentgen appearance should suggest further careful investigation of the lunate, bearing in mind the strong possibility of Kienböck's disease. In our series we have had 5 cases, 4 of them treated with satisfactory results by excision of the lunate. The other case has shown progression of the disease and has been treated conservatively. Two presented a history of a crushing type of injury and 2 a history of indirect force. One gave no history of injury. This patient (Fig. 12) refused surgery, but received considerable temporary relief from small doses of intermediate roentgen therapy directed to the lesion.

#### OTHER INJURIES OF THE CARPUS

As noted by Sherrill,<sup>25</sup> most injuries of the carpus occur to bones of the proximal row and greater multangular. This happens when ordinary mechanisms of injury are operative. However, when gunshot wounds

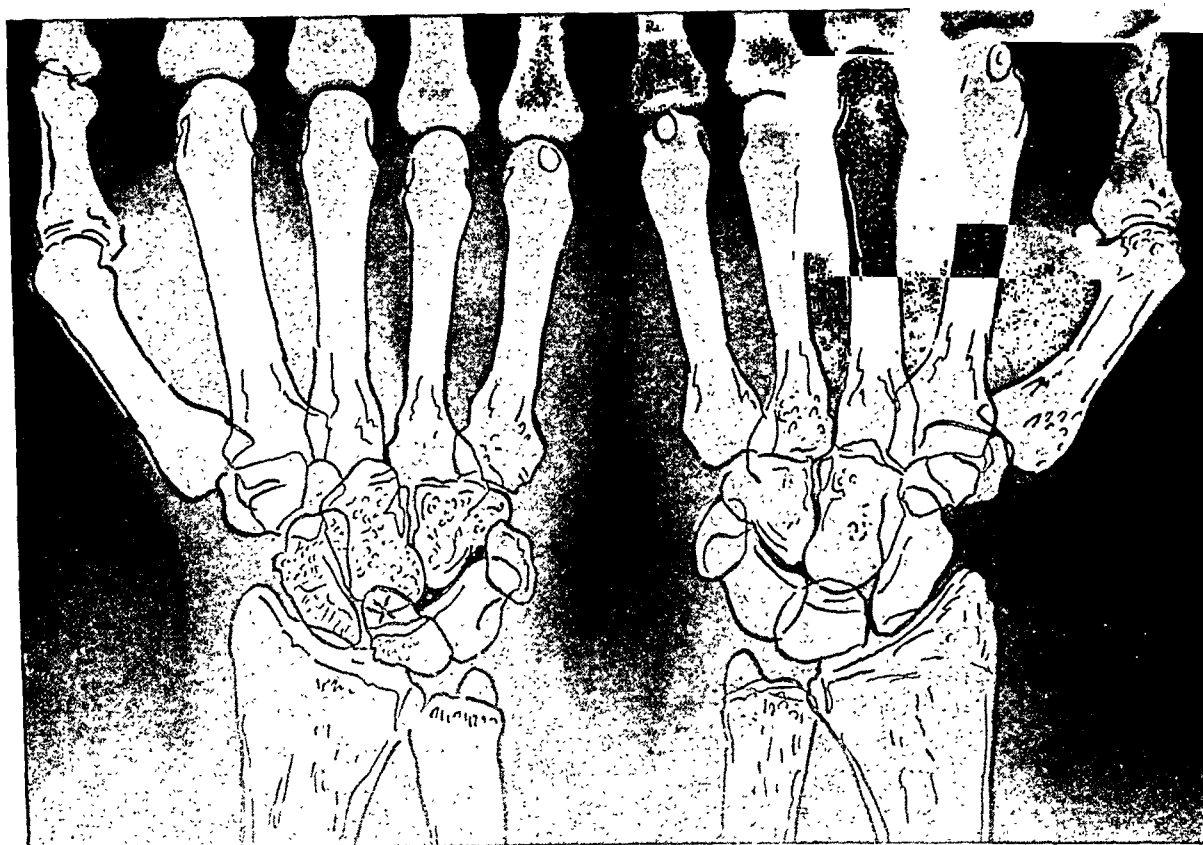


FIG. 12. Kienböck's disease. This figure illustrates well the dorsal tongue-like projection (x) of the lunate in Kienböck's disease, as described in the text. This patient was a young woman, active athletically, but who gave no definite history of injury. The wrist was treated on three different occasions with roentgen therapy, the fields having been accurately marked out under fluoroscopic control beforehand. On all occasions the patient received temporary benefit; however, serial films revealed a progression of the disease.

Since the method of illustration used in this paper has not been described before, it may be worth while to briefly mention it. The film that is to be used for reproduction is covered with a sheet of transparent film and made secure with Scotch tape. An outline of the structures is then traced onto the transparent film and the film with tracing superimposed is then sent to the photographer.

are encountered, no set rules apply—the question of site of injury depends upon the direction and the course of the speeding missile. Consequently, in this hospital we have encountered extensive fractures of all carpal bones; sometimes singly, but more often in combination. It is obvious that with bone injuries due to high explosive fragments there is likely to be considerable shattering and fragmentation of the parts. Howard,<sup>10</sup> in a personal communication, has described a typical extensive destruction that is often a problem. He calls attention to dorsal dislocation of the bases of the metacarpals, dragging with them a variable amount of the distal carpus, usually a part of the capitate (Fig. 13). He

feels that since the capitate serves to lock the two carpal rows, fracture through it may be a predisposing factor. The end result is a shortening of the hand with all of the metacarpals angled forward so that the thumb cleft is narrowed and the thumb becomes less useful. The mechanics of finger flexion is so altered that the grip lacks power. Dorsal flexion of the wrist is generally blocked and often the radial carpal articulation injured. Regarding treatment, he says, "In these cases I have been correcting the deformity surgically, utilizing iliac bone graft if necessary, making sure to restore the angle of the metacarpals with the carpus or even increasing this angle somewhat when the

radial carpal articulation is poor."

In our casually selected group of carpal injuries 5 lesions of the capitate are of interest. One of our capitate injuries is a single fracture through the proximal portion of the head; 3 were fractures associated with other injuries such as fracture

of the os magnum, with no evidence of fracture, was encountered (Fig. 14). This lesion occurred in a wrist which had been traumatically amputated at the carpal-metacarpal joint by an exploding booby trap. At the same time the multangular bones were also amputated and the navic-



FIG. 13. Fracture of capitate, lesser multangular and scaphoid bones as well as fractures of the bases of the second and third metacarpals with posterior dislocation at the carpal metacarpal joint. These multiple injuries were caused by a sniper bullet on October 3, 1944. A posterior fragment, indicated at *a*, was removed and the dislocation reduced on July 11, 1945. The fractured carpus healed with but moderate deformity. Moderately severe traumatic arthritic changes developed, but the patient was discharged, improved, to Occupational and Physical Therapy. At *b* is seen a dense proximal fragment of the fractured navicular. The letters *c* indicate fragments of the fractured os magnum.

of the lesser multangular and navicular (Fig. 13), fracture of the hamate, and fracture of the triquetral respectively. The fractured capitate associated with fracture of the triquetral presents aseptic necrosis of the head. In this case the aseptic necrosis is secondary to fracture. In the fifth capitate lesion an aseptic necrosis of the head

ular fractured. Revascularization and revitalization of the heads of both capitates described may well take place in time. Jönsson<sup>11</sup> has reported a case of isolated aseptic necrosis of the capitate, in which the proximal portion became flattened. Subchondral rarefactions were observed. Over a period of months the distal

half developed a distinct sclerosis and the proximal part showed small broken down fragments of bone pressed together into an irregular structureless mass. This disease process occurred in a student nurse, aged twenty-two, who gave no history of injury.

within the bone, as Bunnell suggests. The rarity of aseptic necrosis of the capitate is probably a direct consequence of the infrequency of capitate injuries.

Four fractures of the hamate were collected. One is a fracture of the hamulus, the

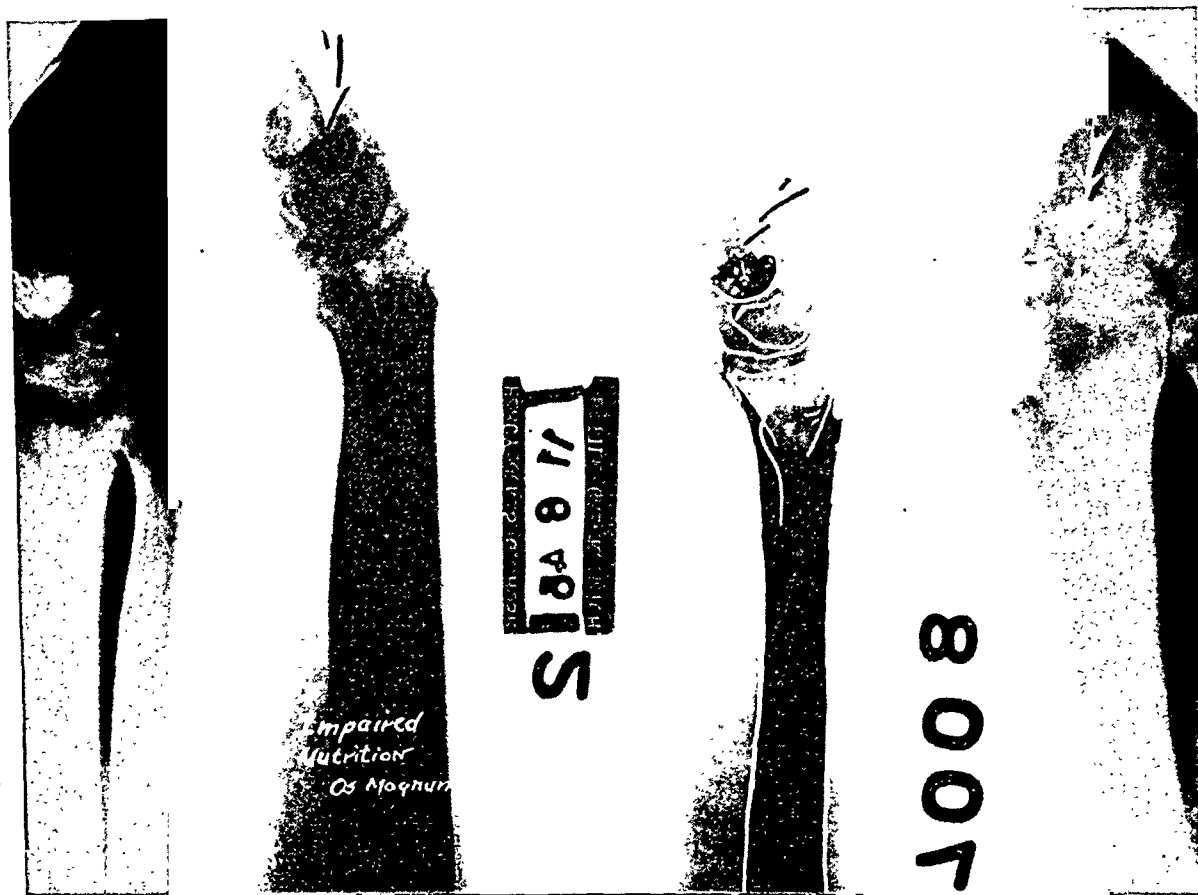


FIG. 14. Aseptic necrosis of head of os magnum without evidence of fracture. This distal carpal amputation was produced when a booby trap exploded in the patient's hand on June 14, 1945. The multangular bones were also amputated and the navicular fractured in this injury. Roentgen examination at Percy Jones General Hospital on November 1, 1945, showed the amputation with aseptic necrosis of the head of the os magnum and ununited fracture of the navicular. Arrows indicate the area of aseptic necrosis. Note the marked demineralization of the remainder of the carpus.

This case, as Jönsson notes, closely simulates Kienböck's semilunar malacia. Our cases, on the other hand, have more the appearance of aseptic necrosis as seen in the proximal fragment of a fractured navicular. Presumably the fundamental pathology in all of these cases is due to interference of blood supply, whether this be a complete severance of blood vessels at the time of fracture or a cutting off of the blood supply due to increased pressure

ununited distal fragment eventually having been removed (Fig. 15). Another was a shattered hamate. A third fractured hamate was associated with fracture of the capitate. The fourth case was a shattered hamate, triquetral, pisiform and fractured lunate complicated further by osteomyelitis (Fig. 16). This last case is not unusual in our experience and exemplifies many similar cases seen in battle casualties.

There are 2 cases of fracture of the lesser



FIG. 15. Fracture of hamulus of hamate. This injury occurred in a twenty-eight-year old Sergeant who fell on his outstretched hand while skiing on November 24, 1942. Roentgenograms at the time revealed no fracture of his wrist. However, his wrist continued to be painful over a number of months in spite of various types of therapy. Physical examination on September 9, 1943, showed an ovoid cystic mass 3 cm. in diameter just over the transverse carpal ligament apparently fixed to the flexor tendons of the third, fourth and fifth fingers. Hyperextension and forced flexion of the third and fourth fingers caused some pain. Roentgenograms showed an old injury of the hamulus of the hamate apparently with some bone loss at the base of the hamulus and an old ununited fracture of the distal hamulus. On November 25, 1943, the ununited fragment was removed and the cystic mass opened at operation. The cystic portion was found to involve the ulnar bursa and to contain a material resembling boiled rice. The tendons in this same region and the tissues about them showed evidence of a plastic exudate. The patient was discharged greatly improved with a final diagnosis of "ununited fracture of the hamulus of the hamate, nonspecific chronic granulomatous lesion involving the ulnar bursa and tenosynovitis of the flexor profundus tendon of the ring finger, right." It is not known whether the chronic granulomatous lesion was secondary to injury or whether it represented an incidental inflammatory lesion (tuberculosis?) of the ulnar bursa. Tissue section showed nonspecific chronic inflammatory tissue. The left wrist shows a normal well rounded hamulus as indicated by the arrow. The right wrist shows the deformed hamulus with the ununited fracture. The projection shown above is the so-called "tunnel view" of the carpus.

multangular bones—one a chip fracture, the other discussed above, was associated with a fractured capitate (Fig. 13). One fracture of the greater multangular has been encountered (Fig. 17). This fracture occurred through the outer third of the

bone, permitting a proximal and posterior subluxation of the first metacarpal with consequential shortening of the thumb. The injury occurred when the patient was struck by fragments from a mortar shell. However, even though there is a metallic

FIG. 17. Fracture of greater multangular. This nineteen year old private was wounded in action on October 22, 1944, when struck by a fragment from a mortar shell. He sustained multiple high explosive fragment wounds involving the neck, thorax, abdomen, elbow, face and thighs, and a small wound over the left thenar eminence. A metallic fragment is present in the soft tissues of the lower forearm, but the appearance of the greater multangular fracture suggests an indirect injury. The patient may have fallen on his hand since he was knocked unconscious at the time of injury. The lateral fragment of the greater multangular is seen at *a*.



FIG. 16. This extensive injury occurred when an enemy bazooka shell struck the tank in which the soldier was riding. The hamate, triquetral, pisiform and lunate bones were shattered, in addition to multiple fractures of the bones of the hand. Osteomyelitis further complicated this injury with fusion of the remaining carpal bones into a solid mass.

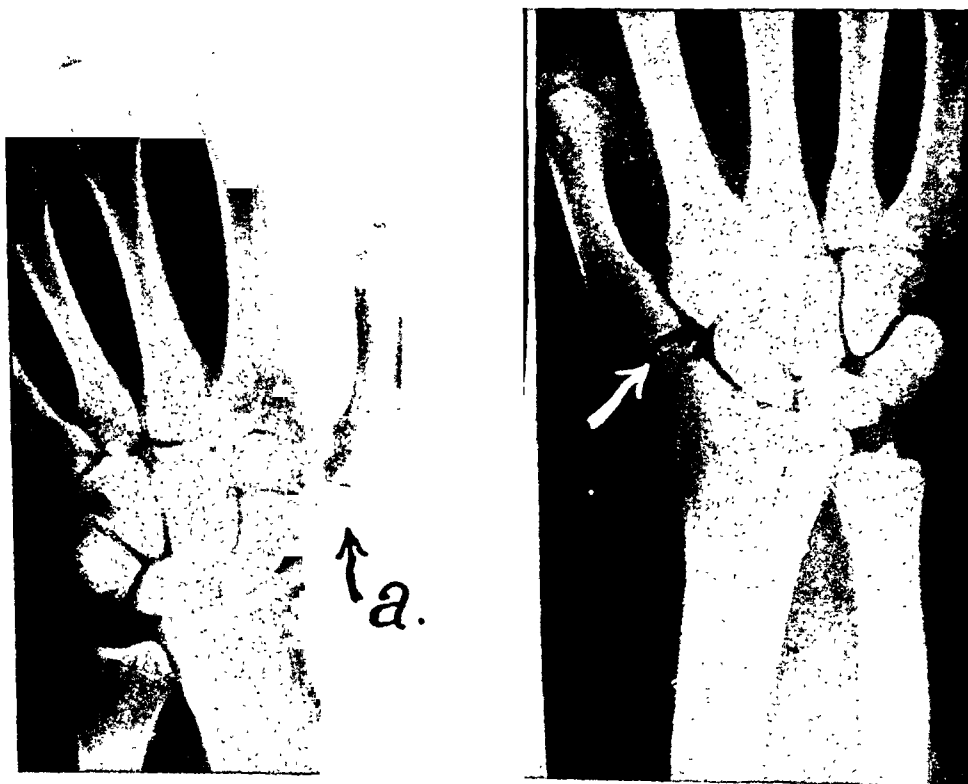


FIG. 17





FIG. 18. Fracture of triquetrum and pisiform. This patient received his injury in Germany on February 24, 1945, suffering compound, comminuted fractures of the lower third of the right radius and ulna and fractures of the pisiform (*a*), triquetrum (*b*), and the lunate bone (*c*); *d* indicates a fragment from the triquetrum. Note splint and irrigation tube. Most of our fractures are compound.

fragment present in the lower forearm this fracture is more suggestive of injury by indirect force, which type has been described by Greene and Miller.<sup>8</sup>

Five fractures of the triquetrum are included in our group. Three were associated with fractures of the pisiform bone, one of which is demonstrated in Figure 18. Two showed fractures through the center of the bone, 2 were shattered and 1 showed a chip off the dorsal aspect of the triquetrum. The latter type of injury is seen not infrequently in our department. Only 1 was uncomplicated by other carpal injuries. There were 3 fractures of the pisiform. None of these was badly comminuted and the fragments of all fractured pisiforms

seen were in satisfactory position. Possibly the unique position of this bone accounts for the absence of fragmentation when other bones of the wrist were shattered.

#### SUMMARY

We have presented a group of carpal lesions coming under observation in our department at the Percy Jones General Hospital. These lesions have been selected from our most interesting cases. Fractures of all the carpal bones and dislocations of the lunate have been discussed and exemplified as they occur in strenuous military training and battle injuries. Five cases of Kienböck's disease have been reported and a roentgen finding in semilunar malacia,

hitherto undescribed as far as is known, is recorded. Two cases of aseptic necrosis of the head of the capitate are described and the mechanism of its production is discussed. A technique for roentgen examination of extremities using the Morgan-Hodges phototimer has been found to be especially valuable in orthopedic roentgenography.

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# THE MEDIAL FEMORAL TRIANGLE OF TRANSLUCENCY SIMULATING OSTEOCHONDRITIS DISSECANS

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**O**STEOCHONDRITIS dissecans is a term which was first coined by König in 1887 to describe a subcartilaginous loosening up, as if by dissection, of bone fragments notably in the knee on the medial femoral condyle. The condition was first noted in 1738 by Alexander Munro who suggested that the separation of the loose body was due to trauma. It is more rarely found in the lateral femoral condyle as well as in the subarticular surfaces of other joints of the body. It is predominantly a disease of young adults, more frequent in males. It is apparently a form of aseptic necrosis, the etiology of which is still somewhat obscure. Trauma, especially combined with torsion, is definitely related in most cases, although it is also seen bilaterally; one side without clinical symptoms. While it is seen most frequently in the knee, it has also been observed in other joints, some of which were non-weightbearing. The frequency of involvement of the medial femoral condyle is probably due to the fact that this condyle bears the brunt of the body weight and consequent major and minor traumata of everyday life.

In a typical case, a small, rounded, oval, triangular or irregular bone fragment is seen in the subarticular region of the medial femoral condyle surrounded by a translucent zone. The involved area is often on the lateral side of the medial condyle near the intercondyloid notch. The separated fragment may become much smaller than the area from which it arose and in time may separate and form a loose joint body leaving behind a depression or zone of diminished density. The borders of this zone usually appear indistinct. It may in time fill in with normal bone and all traces of former pathology may disappear.

I have at times noted a triangular zone

of translucency on the lateral aspect of the medial femoral condyle associated frequently with a history of trauma and pain on the medial side of the knee. This appearance suggests osteochondritis dissecans after separation of the loose bony fragment. It is at any rate an interesting normal phenomenon. In a personal communication from Dr. S. Cochrane Shanks,\* he states that he has noticed this area and agrees that it "closely simulates the shallow bed left after the separation of a scale of bone in osteochondritis, but in the latter condition usually the outline of the translucent area is more irregular." I have been unable to find any reference to this phenomenon in the literature although I am quite sure that it has been noted by many roentgenologists.

The triangle was at first thought to be of clinical significance while observing roentgenograms of individuals complaining of knee joint pain with definite histories of trauma. It was later noted in occasional normal knees and was found to vary in size and shape in different individuals.

I am of the opinion that this zone of translucency is due to the variation in width and shape of the lower medial border of the inner femoral condyle as it sweeps upward and laterally. The medial aspect of the intercondyloid notch is thinner in some individuals giving rise to this peculiar triangular zone of decreased density. In most cases observed, the borders of this triangle were sharp and well defined but in some this sharpness was not noted. Another differentiating point is the fact that this anatomical triangle is almost invariably superimposed on the medial tibial spine whereas most cases of osteochondritis

\* Personal communication, January 26, 1945.

dissecans observed were medial to this area.

Figure 1 illustrates a typical case of osteochondritis dissecans showing the location of the translucent bed and the separating necrotic bone fragment.

Figure 2 illustrates the translucent anatomical triangle in a white male, aged twenty-four, injured in a football game in 1939. His knee has "locked" on several occasions since date of injury. Roentgeno-



FIG. 1. Typical case of osteochondritis dissecans showing the location of the translucent bed and the separating necrotic bone fragment.



FIG. 2. Illustrating the anatomical medial femoral condylar translucent zone at the same site as is frequently seen in osteochondritis dissecans. This patient's knee has "locked" on several occasions since injury in a football game in 1939. He had persistent pain in the knee.

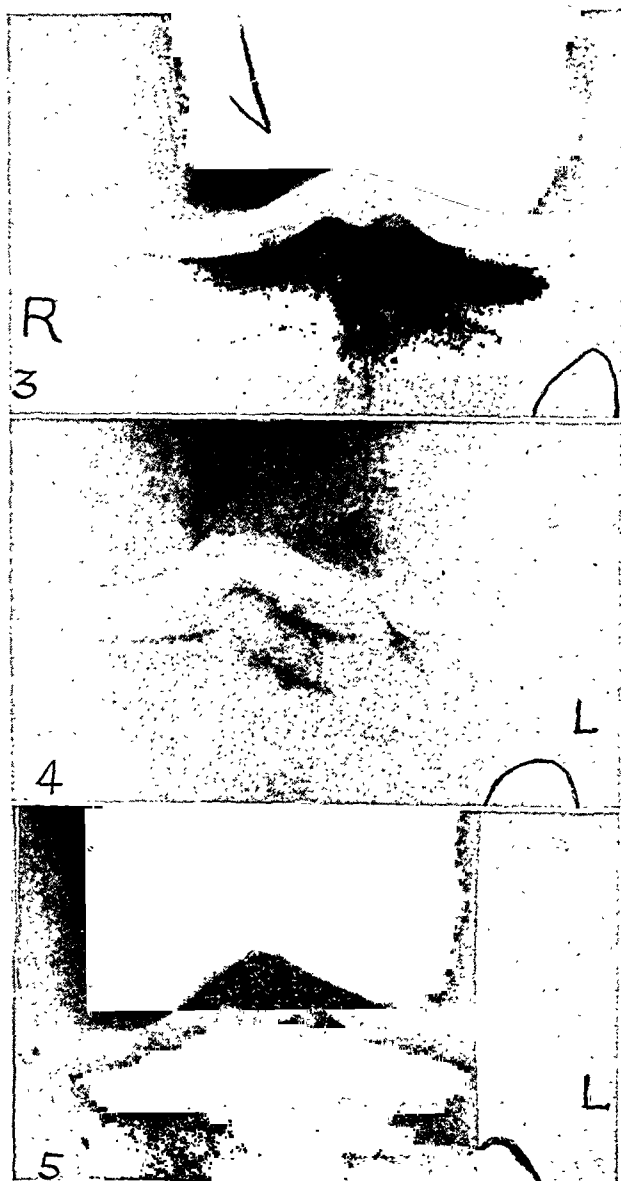


FIG. 3, 4 and 5. Roentgenograms illustrating different sizes and shapes of the medial femoral triangle noted in routine examinations.

gram of right knee was made October 19, 1944.

Figures 3, 4 and 5 represent different sizes and shapes of medial femoral triangles noted in routine examinations.

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# METASTATIC CARCINOMA OF THE HYPOPHYSIS CEREBRI\*

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**C**ARCINOMA of the hypophysis cerebri is rare, and a lesion which has metastasized to the pituitary body from some other source is so uncommon as to be of considerable interest, particularly when we consider that the pituitary body is a not uncommon site for tumors; in fact, about 20 per cent of all intracranial tumors are of pituitary origin, and at autopsy small tumors are often found originating from the chromophobe cells which were evidently asymptomatic during life. These tumors, however, are adenomas and do not originate elsewhere, nor do they metastasize.

There is another group of pituitary tumors which are more rapidly growing than the adenomas. They are more apt to become malignant in the sense that they may metastasize and actually invade adjacent structures instead of displacing them as the adenomas do. Such tumors usually originate from the chromophobe cells and are apt to show the presence of numerous mitoses, and more infrequently do we find such neoplasms originating from the chromophile acidophilic or basophilic cells; and rarest of all is to find a tumor of any kind originating from the posterior portion of the gland. This is not surprising when we consider that the posterior portion of the gland consists of the median eminence of the tuber cinereum, the infundibulum, the infundibular stem, and prominence, all of which are made up of pituicytes (Bucy), connective tissue, and unmyelinated nerve fibers—not a favorable bed for tumor origin. It is of interest to note that the chromophobe cells give rise to most pituitary tumors, in fact about 70 per cent of them, in spite of the fact that the chromophobe cells constitute only about 52 per cent of the cells of the anterior portion of the gland.

To make a differential diagnosis on the roentgenogram alone, between an invasive or metastatic pituitary tumor and the more common pituitary adenomata, may well be impossible. The chances of making such a diagnosis will be increased if we remember to consider the possibility of such a tumor being present, and then bear in mind the various roentgenologic criteria associated with pituitary lesions which are quite well known to all of us; but as a brief recapitulation might be of aid, we will discuss some of the differential points.

The chromophobe adenoma is slow growing, as are all the adenomas, and it is the most common of the pituitary tumors. It is apt to be quite large before anyone thinks it worth while to obtain roentgenograms of the head. The tumor produces a "ballooning" of the sella turcica, and if it bursts through the diaphragma sellae or extends laterally it will displace but rarely include adjacent structures. The mass is seldom large enough to block any of the cerebral fluid pathways sufficiently to cause increased intracranial pressure, in fact less than 3 per cent of the pituitary tumors give rise to an elevation of intracranial pressure. Such tumors may on rare occasions extend laterally far enough to depress the floor of the middle fossa on one side and even enlarge an optic foramen. The atrophy seen in the sella turcica may be slight or may vary in amount up to complete destruction. The bone will have a clean cut, atrophic appearance rather than the fuzzy invasive appearance of destruction; however, it is often difficult to differentiate between these two changes as they differ in degree only. With a chromophobe tumor, the skull will show none of the changes of acromegaly.

The chromophile acidophilic type of adenoma is usually much smaller than the

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chromophobe type and is much less common. The changes in the sella turcica are similar to those produced by the chromophobe tumor, but less well marked, and in addition there will be present the characteristic changes in the skull of acromegaly. If we find a large atrophic sella turcica with acromegalic changes in the skull, then we are probably dealing with a mixed tumor combining some of the characteristics of both types, with the chromophilic cells predominantly active.

The basophilic type of tumor is usually quite small and may be discovered only on microscopic study of the gland. The roentgenologic findings in the presence of a basophilic pituitary adenoma are usually not marked in the sella turcica. The changes are slight general lack of bone calcium throughout the skull, but most noticeable in the calvarium where the bone will have a somewhat mottled and granular appearance not unlike the changes associated with hyperparathyroidism. In fact, in cases where there is no atrophy of the sella turcica, it would be difficult to differentiate between these two conditions were it not for the fact that basophilism is usually associated with Cushing's syndrome.

There is another tumor which is usually thought of as one of the pituitary group of lesions and must be differentiated from them. This tumor arises from squamous epithelial rests and originates in the tuber cinereum or in the remains of Rathke's pouch in the anterior lobe of the pituitary gland. These lesions are usually known as craniopharyngiomas, and as they frequently calcify and cause an increase of intracranial pressure, together with a considerable enlargement of the sella turcica, their identification is rarely a problem, and in addition they are usually found in young people.

We may rarely find an epidermoidoma associated with the pituitary; a gumma or even a tuberculoma may also complicate the picture. With the exception of the tuberculoma which might calcify, we could hardly hope to differentiate these lesions

from the more common pituitary tumors, although a careful consideration of the clinical findings may help in arriving at a more definite conclusion.

Tumors of the pituitary body which might be termed carcinomatous are indeed rare. Statistics are sometimes difficult to evaluate, but certainly such tumors constitute a very small percentage, probably not more than 2 per cent or even less. In my experience, the frequency of such tumors is less than 1 per cent. It seems highly probable that some of these tumors may well develop from a metamorphosis of the chromophobe cells, and one has been reported as of basophilic origin. These rapidly growing lesions have been termed malignant adenomas by Dott, Bailey and Cushing, rather than adenocarcinomas. The word "malignant" simply means getting worse which is usually true of any of the adenomas, but malignancy has been associated for some time with the idea of metastasizing so that by stretching an etymological point we might use the term "malignant adenoma" to describe these lesions because even though they are not apt to metastasize they may be metastatic and invade rather than displace adjacent structures.

Bearing in mind the facts about pituitary tumors as set forth above, how are we going to make a differential diagnosis of a malignant hypophyseal lesion? First we must study the history: the malignant lesion will have a rather short, rapidly progressive symptomatology, while a pituitary adenoma would cause a more slowly progressing chain of events. Both however, would in the early stages present quite comparable symptoms. It is interesting to note that endocrine disturbances are not apt to be as outstanding with the malignant growths as with the adenomas. Perhaps because the malignant growth is so rapidly destructive, the endocrinopathies do not have time to become evident before death occurs.

Second, the roentgenologic changes must be carefully evaluated because the extent of the sellar destruction is no criterion. A

malignant tumor may be small, and an adenoma may be large. The malignant tumor usually invades the bone and produces complete destruction, whereas the adenoma causes pressure atrophy and usually we can make out a pseudocortex or shell marking

example of a metastatic lesion of the pituitary gland:

The patient, male, aged forty-eight, was admitted to the hospital on the service of Dr. D. A. MacDonald. The patient gave a history of being well until ten weeks prior to admission when he began to have pain in the left ear followed by pain in the left face with temporal and frontal headaches. Eight weeks before hospitalization, he began to have weakness of the left eyelid and inability to move the left eye. There was no vertigo or tinnitus. He was admitted to the hospital because of attacks of pain simulating cholecystitis.

The chief points of interest brought to light by examinations by Dr. L. C. Herning and Dr. W. D. Wingeback were ophthalmoplegia of the left eye but with the pupil reacting. There was no evidence of papilledema. There were no other cranial nerves involved and general neurological examination was essentially negative.

Examination of the skull (Fig. 1) was interpreted as revealing the presence of a large pituitary adenoma with reservations as to the possibility of there being a malignant factor present. Had the history been more carefully studied, the diagnosis probably could have been more definitely made. The short ten weeks' history would hardly be compatible with the usual pituitary adenoma, and in addition, the man was not typically endocrinopathic.

The patient was given roentgen irradiation to the pituitary region, but after receiving 2,000 roentgens distributed over the usual three fields of entry, his condition became rapidly retrogressive and he died.

The autopsy report and pathological findings by Dr. P. T. MacIlroy are as follows:

#### *Microscopic Examination.*

*Liver:* Shows metastatic new growth. Large masses of cells in epithelial union are seen invading the parenchyma of the liver.

*Suprarenals:* Show the presence of metastatic malignancy resembling that seen in the liver.

*Pancreas:* Not remarkable.

*Kidneys:* The cells lining the convoluted tubules in many instances have lost their nuclear staining. The cells have a granular appearance.

*Spleen:* Not remarkable.

*Intestinal Wall:* Shows invasion by cells in epithelial union forming, for the most part, large gland tubules. Areas of necrosis and

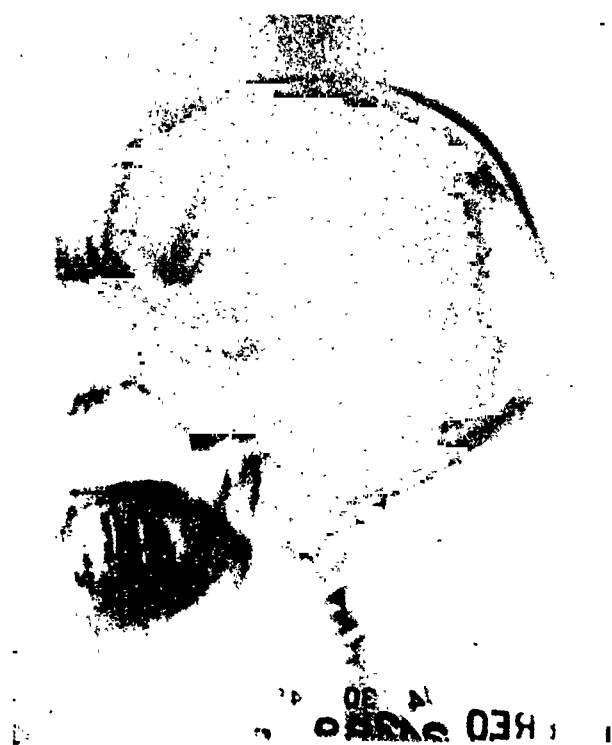


FIG. 1. Pituitary carcinoma (metastatic). The calci-fied streaks behind the sella turcica are in the free edges of the tentorium and not associated with the tumor.

the limit of the extent of the tumor. It is quite evident that these types of destruction blend one into the other so that at times in the roentgenogram the results would appear the same. The malignant growth is somewhat more apt to invade the sphenoid cells than is the adenoma, particularly when the cells are extensive and the floor of the sella turcica is thin. The tumor may occasionally be seen within the air cell. The adenoma often depresses the sellar floor but usually does not completely destroy it. With either type of tumor, if the sphenoid cells are invaded, there may be a cerebral fluid drip from the nose.

The following case is offered as a good

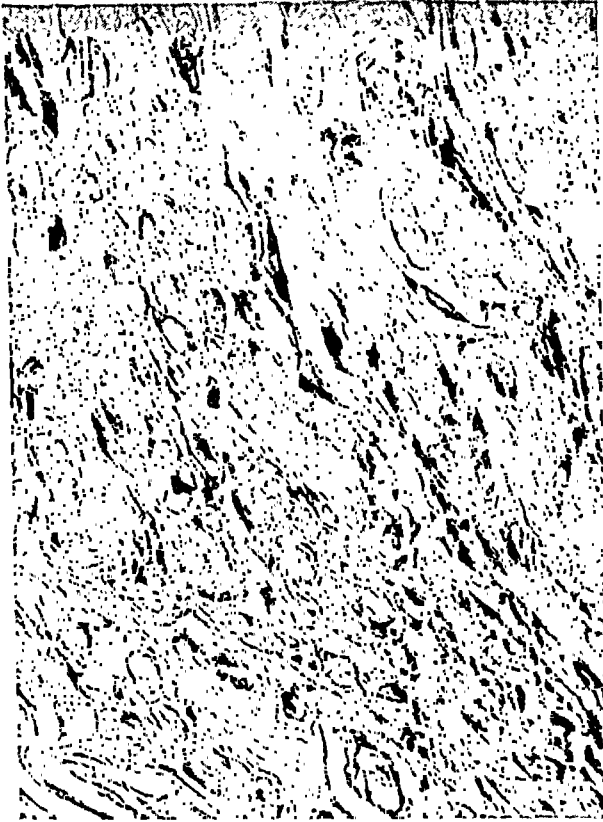


FIG. 2. Photomicrograph of the tumor. There are numerous areas of degeneration.



FIG. 3. Photomicrograph of tumor, same as Figure 2, different area.

muroid degeneration are present. Foci of chronic inflammation are seen in the surrounding stroma.

**Hypophysis:** Shows invasion by cells in epithelial union forming gland tubules resembling those seen in the colon. The central portions of the growth show considerable necrosis. In the well nourished areas, on the other hand, the growth presents a hyalinized appearance, probably the result of roentgen therapy.

**Histopathological findings:** Primary carcinoma of the colon; metastases to the liver and suprarenals; metastatic adenocarcinoma of the hypophysis showing hyalin degeneration.

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## PLANIGRAPHY

### III. AN EVALUATION OF THE METHOD IN THE DIAGNOSIS OF CANCER OF THE LOWER RESPIRATORY TRACT\*

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#### INTRODUCTION

A REVIEW of the history of the utilization of planar roentgenography in the study of cancer of the lower respiratory tract shows that the usefulness of the method was understood and appreciated as early as 1935 when Chaoul<sup>3,4,5</sup> published his fine work. He showed by serial section study of normal and pathologic lungs how the bronchi and their branches, pulmonary cavities, and extension of pathological processes could be demonstrated. A planar roentgenogram of a living patient, made by the senior author of this study in 1937, showing obstruction of the left main bronchus was published in a review by Freedman.<sup>8</sup> Despite the fact that the wide range of usefulness of this procedure was recognized by many, little has subsequently appeared in the literature regarding its employment in the study of cancer of the lower respiratory tract.

Mention is made of the procedure by Gravano and Malenchini<sup>9</sup> in the Argentine literature of 1937. In 1939 Dreyer<sup>6</sup> published one case showing defective aeration of a portion of the stem bronchus. Olds and Kirklin<sup>12</sup> published an excellent film in 1940 which showed clearly an obstructive mass in the left main bronchus with atelectasis of the left upper lobe. Fariñas,<sup>7</sup> in the same year, illustrated by planar roentgenography the infiltrative character of a tumor mass in the lung parenchyma. It remained for Moore<sup>11</sup> to publish, also in

1940, the first definitive treatise on the employment of the method in the study of cancer of the lower respiratory tract and in this study the many and varied roentgenographic images which may be encountered were shown.

Sparks<sup>13</sup> mentioned in 1943 the use of the procedure in the study of cancer of the lung and showed a simple diagrammatic representation of two typical cases. Closely allied, at least in some clinical manifestations, to bronchiogenic carcinoma is adenoma of the bronchus. A definitive planar roentgenographic study of this disease by Lowry and Rigler<sup>10</sup> appeared in 1944 and in it the authors employed the procedure to demonstrate the actual intrabronchial tumor.

The present study was undertaken to determine just how specific the planar roentgenographic findings may be in the diagnosis of cancer of the lower respiratory tract.

Of all the roentgenographic findings which may be associated with primary cancer of the lower respiratory tract the most pathognomonic is bronchial obstruction as manifested by atelectasis. If planar (body section) roentgenography could be relied upon to demonstrate the bronchial obstruction itself and if bronchial obstruction were not simulated or caused by non-neoplastic inflammatory diseases then the procedure could be depended upon as

\* Part III of thesis submitted by Dr. Andrews to the Faculty of the Graduate School of Medicine of the University of Pennsylvania in partial fulfillment of the requirements for the degree of Doctor of Medical Science (D.Sc. (Med.)) for graduate work in radiology.

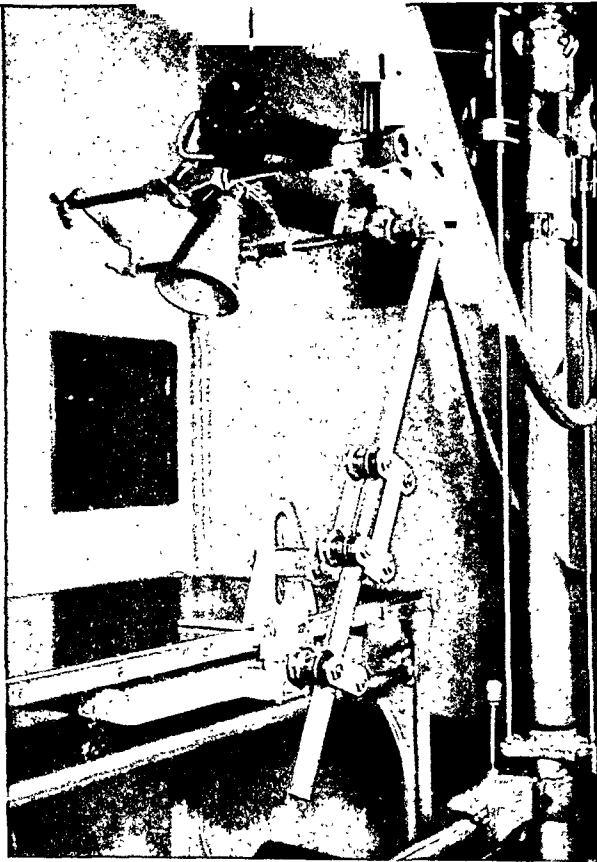


FIG. 1. Planar roentgenographic apparatus employed by the authors.

specific in the diagnosis of cancer.

Endobronchial tumor; circumscribed or ill defined pulmonary infiltration; necrosis

and abscess; tracheal or bronchial displacement; pleural effusion; exudate or hemorrhage; bronchiectasis; and enlarged mediastinal nodes, as well as bronchial obstruction and atelectasis, may likewise be found in association with cancer of the lower respiratory tract and may be demonstrated by planar roentgenography. It is the purpose of this study to determine how specific any of these findings, occurring singly or in combination and demonstrated by planar roentgenography, may be in the diagnosis of cancer.

The planar roentgenographic apparatus employed in this study was designed and constructed by one of the authors (R.O.T.) and is a simple adaptation of the planigraphic method employing rectilinear motion.<sup>1,2</sup> The apparatus is illustrated in Figure 1.

(1) Bronchial obstruction with atelectasis is readily demonstrable by planar roentgenography in cases of endobronchial carcinoma (Fig. 2 and 3). On the other hand, similar planar roentgenographic evidence of bronchial obstruction is also found in metastatic tumor (Fig. 4*B*), unresolved or slowly resolving pneumonia (Fig. 5*C* and 6*B*), acute pneumonic consolidation (Fig. 7*B*), and uncomplicated

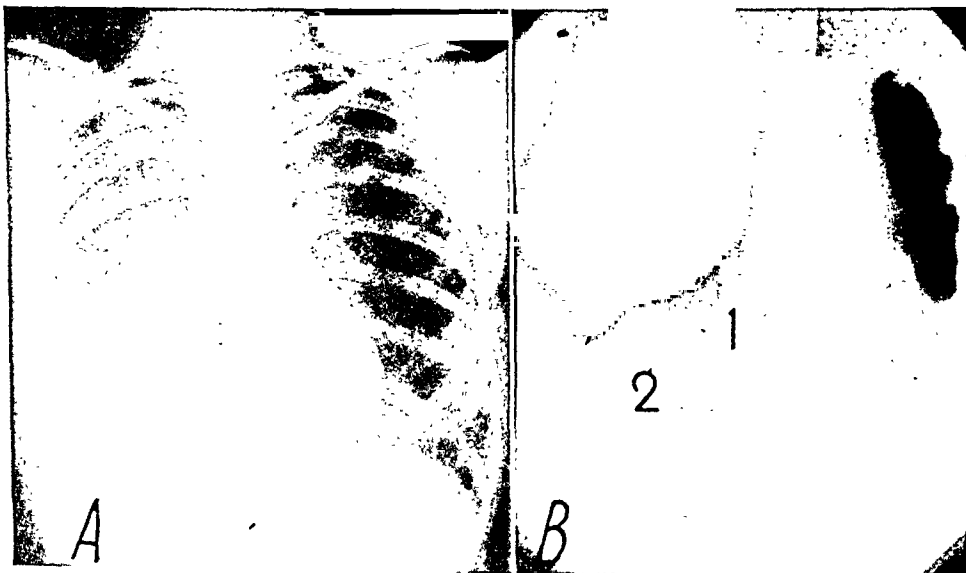


FIG. 2. Case 1, *A*, carcinoma of stem bronchus. *B*, constriction of stem and right lower lobe bronchi (1) and infiltration of pulmonary parenchyma (2).

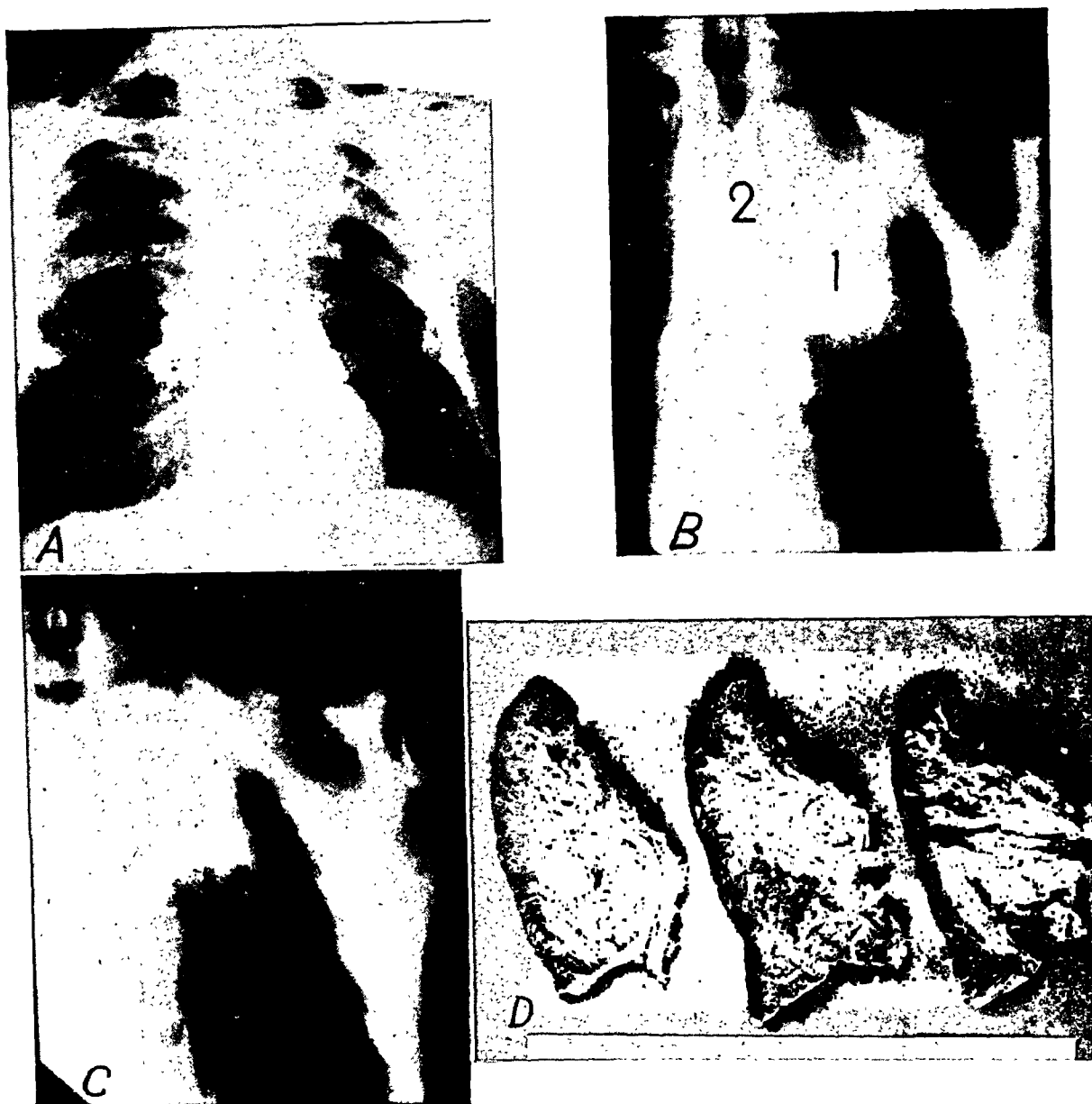


FIG. 3. Case 11. *A*, carcinoma of left upper lobe bronchus. *B*, obstruction (no visualization) of left upper lobe bronchus, infiltration of pulmonary parenchyma (*x*), and retraction of trachea (*2*). *C*, multiple thin-walled cavities in left upper lobe tumor mass. *D*, multiple, contracted, small cavities in apex of fixed specimen of left upper lobe.

pleural effusion (Fig. 8*B*). The fact that bronchial obstruction or simulated bronchial obstruction may be found by planar roentgenography in the presence of non-neoplastic inflammatory lesion negates, therefore, the specificity of this finding in the diagnosis of endobronchial carcinoma.

(2) Endobronchial tumor: The demonstration of actual tumor lying within the lumen of the bronchus by planar roentgenography is very unusual. Moore,<sup>11</sup> in his

Case 3, shows an excellent example. This is but one example out of 26 cases of lung cancer cited in that report. Caseous tuberculous lymph nodes may ulcerate into the lumen of a bronchus and such a lymph node, unless it was calcified when a diagnosis of tuberculosis would be presumptive, ulcerating and bulging into the lumen of a bronchus, could be mistaken for carcinoma. A case of calcified and caseous mediastinal lymph node ulcerating into the stem bron-

chus is shown in Figure 9, *A* and *B*. Where, however, a tumor mass can be shown in a bronchus, the possibility of cancer would be very great as caseous tuberculous nodes ulcerating into a bronchus are much less frequent. We have not been able to demon-

renchyma by cancer can be shown by planar roentgenography (Fig. 2*B*, 3*B* and 10*B*). The tumor mass will occasionally be shown on such films as a dense, circumscribed mass while the pneumonic reaction around such tumor will appear as a less dense,

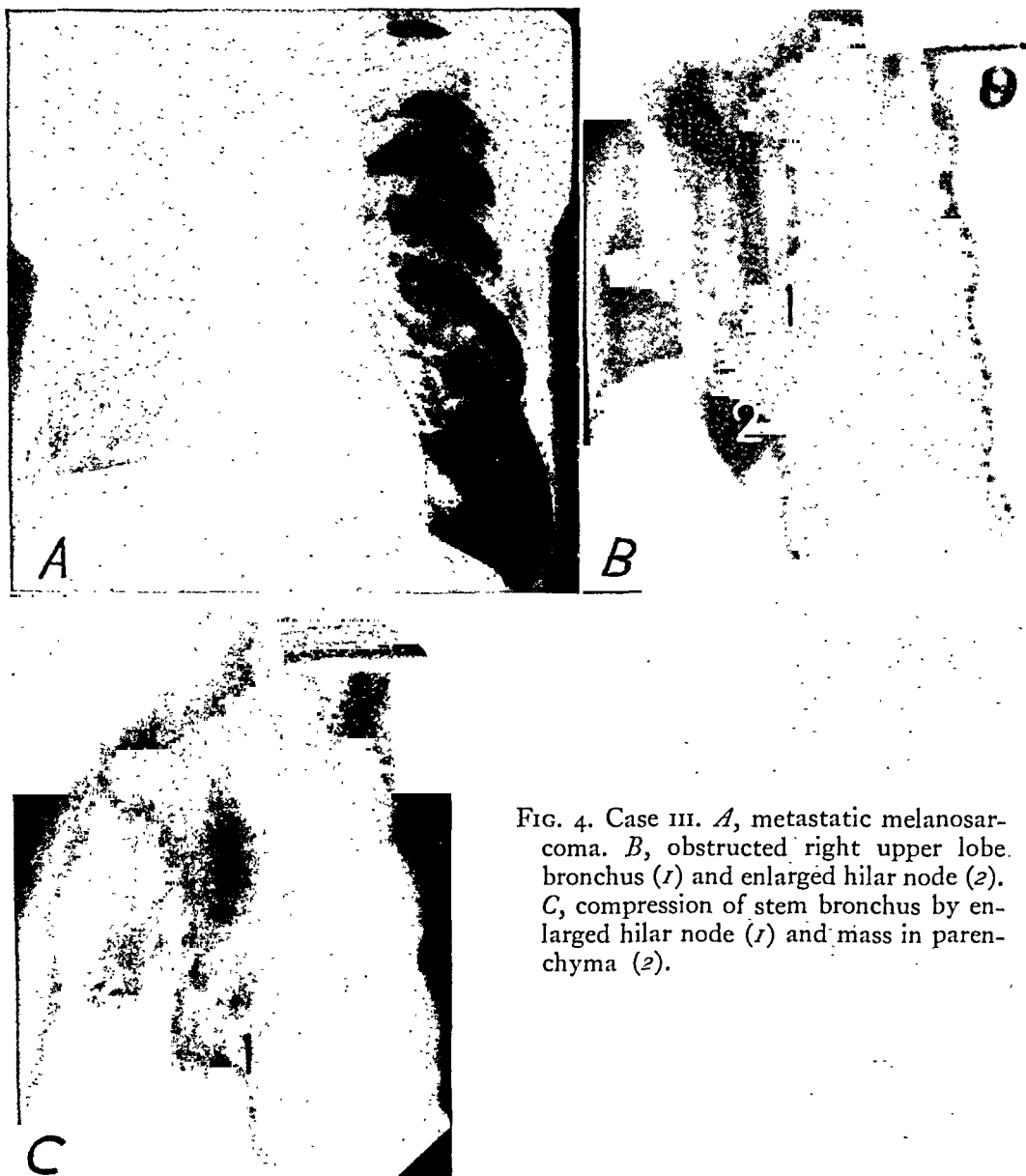


FIG. 4. Case III. *A*, metastatic melanosarcoma. *B*, obstructed right upper lobe bronchus (1) and enlarged hilar node (2). *C*, compression of stem bronchus by enlarged hilar node (1) and mass in parenchyma (2).

strate an intrabronchial tumor mass in our series although surgical and autopsy specimens have shown the presence of this tumor. Although such a finding would have great specificity one must conclude, therefore, that it is very infrequently observed.

(3) The infiltration of pulmonary pa-

ill defined lesion. Such a differentiation generally cannot be made with ordinary roentgenograms. Other lesions, such as metastatic tumor (Fig. 4*C*) and the massive, coalescent, fibrous and hyalin lesions of silicosis (Fig. 11*B*), may present similar circumscribed mass shadows. Pulmonary

infiltration, of more or less characteristic appearance, will of course be found in any parenchymatous lesion of neoplastic or non-neoplastic inflammatory origin on the planar roentgenograms.

(4) Necrosis and abscess: Planar roent-

specificity in the diagnosis of carcinoma. The presence of cavities in a case of endobronchial carcinoma is well shown in Figure 3C. The gross surgical specimen is shown in Figure 3D, where the shrunken cavities can be seen in the fixed material.

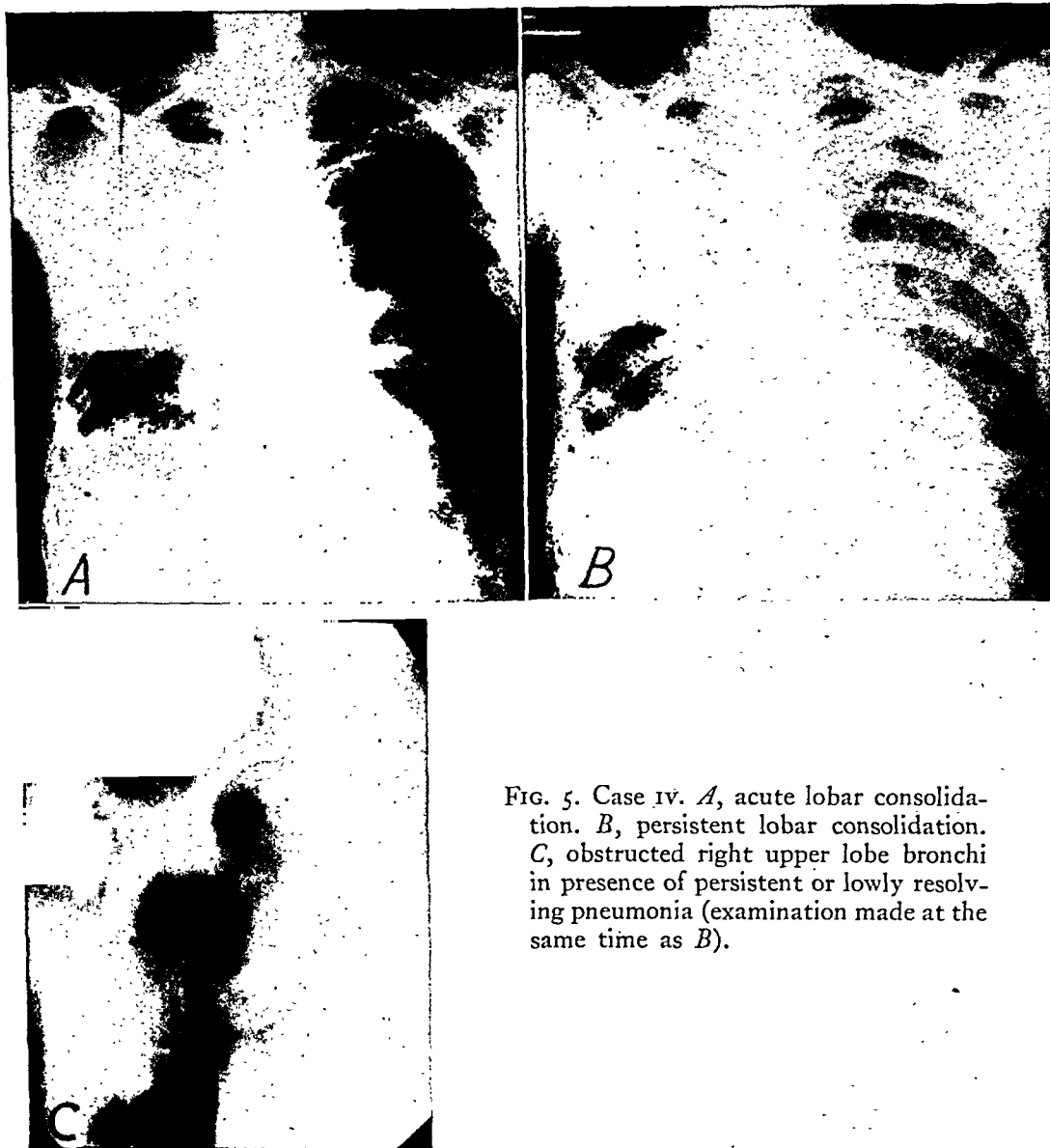


FIG. 5. Case IV. *A*, acute lobar consolidation. *B*, persistent lobar consolidation. *C*, obstructed right upper lobe bronchi in presence of persistent or slowly resolving pneumonia (examination made at the same time as *B*).

genography is now an established procedure for the demonstration and localization of both ill defined and unsuspected pulmonary cavities. Very small and thin-walled cavities become demonstrable but such cavities may be present not only in cancer but in many other parenchymatous lesions. The presence of cavitation loses, therefore, its

On the other hand, cavities appear more frequently in inflammatory lesions. With the use of planar roentgenography cavities have been found with unsuspected frequency in cases of unresolved, or slowly resolving, pneumonia (Fig. 6, *C* and *D*) and one case of an acute, rapidly resolving pneumonia was found in which planar

roentgenography showed the presence of cavity (Fig. 7C) although a subsequent film made seven days later showed that the consolidation and cavitation had disappeared (Fig. 7D) and the patient clinically had recovered.

(5) Tracheal and bronchial displace-

cance for retraction is found in the presence of any lesion which results in organization and cirrhosis of the lung and displacement in the presence of effusion or obstructive emphysema of whatever cause.

(6) Pleural effusion, exudate, or hemorrhage: Any of these may occur in the pres-

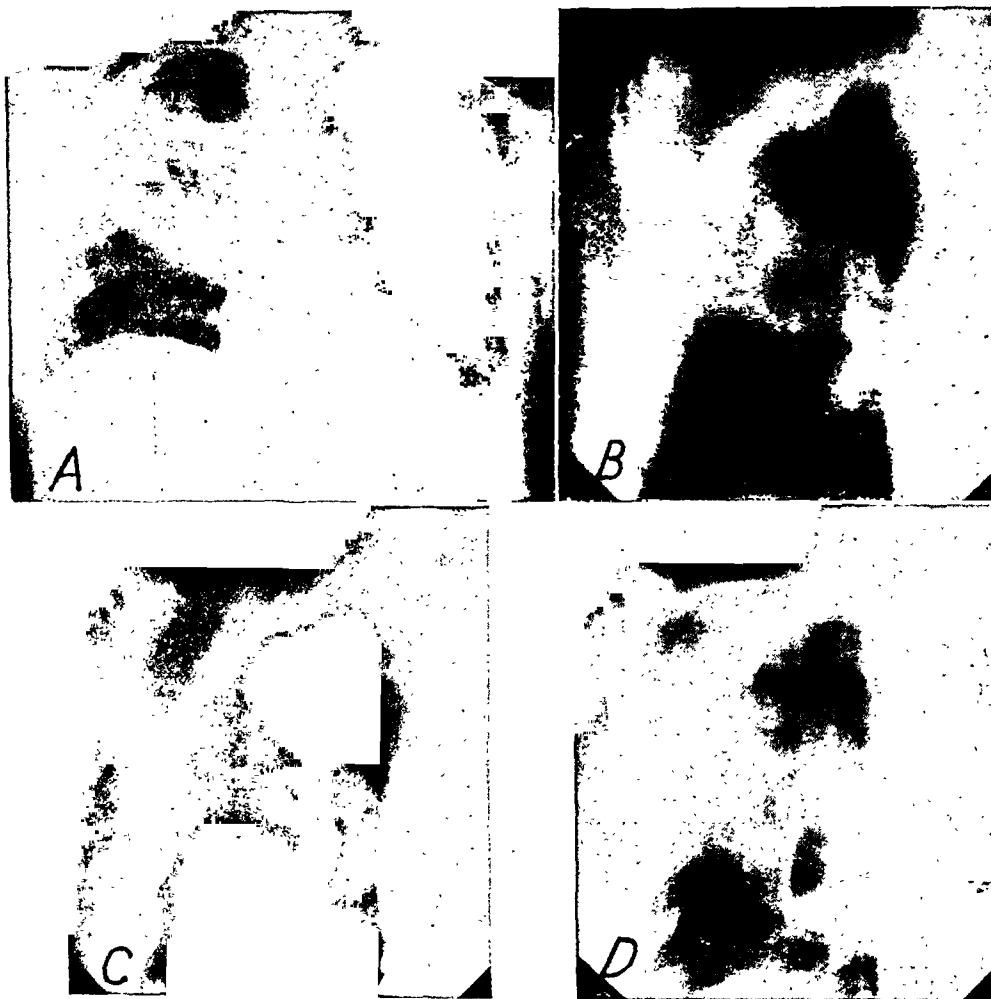


FIG. 6. Case v. *A*, unresolved pneumonia. *B*, obstructed right upper lobe bronchi. *C*, abscess in persistent pneumonia lesion. *D*, abscess in persistent pneumonic lesion (planar roentgenogram made at level different from that in *C*).

ment: Planar roentgenography affords an excellent means for studying alterations of the positions of the trachea and bronchi. In the presence of carcinoma either retraction of the trachea or displacement of it in the opposite direction may be found, the former accompanying atelectasis of a lobe (Fig. 3B) or lung and the latter accompanying expanding tumor or effusion. Such findings are, however, of no differential signifi-

cance of cancer but what is of most importance is the fact that in the presence of uncomplicated pleural effusion findings simulating bronchial obstruction may occur on the planar roentgenograms (Fig. 8B). Figure 8C shows that the effusion has resorbed and that there is no underlying parenchymatous lesion to account for the apparent or actual bronchial obstruction visible on the planar roentgenogram. This

bronchial obstruction presumably is due to compression of lung and bronchi by fluid but unless this possibility is recognized the finding might be interpreted as indicative of obstructive endobronchial carcinoma.

of bronchi. We have not studied bronchiectasis of congenital or inflammatory origin by planar roentgenography but, presumably, there would be no differential findings.

(8) Mediastinal nodes: Autopsy studies



FIG. 7. Case vi. *A*, acute lobar consolidation. *B*, obstruction of small bronchi in right upper lobe. *C*, un-suspected cavity in acute pneumonic lesion. *D*, resolution of acute lobar consolidation seven days after *A*.

(7) Bronchiectasis has been found in the presence of lung cancer (Fig. 10*B*). In this case the tumor was found, at autopsy, to be a diffusely infiltrative one with indefinite localization in the lung and with bronchiectasis in the tumor infiltrated portion of the lung due, evidently, to fixed tissue reaction in this portion with subsequent contraction of parenchyma and dilatation

have indicated that dense, more or less localized shadows occurring in the hilar region or along the main bronchi or vessels on the planar roentgenograms may be interpreted as enlarged mediastinal nodes. Normal hilar shadows will show simply faint branching shadows of blood vessels and bronchi, which can easily be identified, and the complete absence of shadows



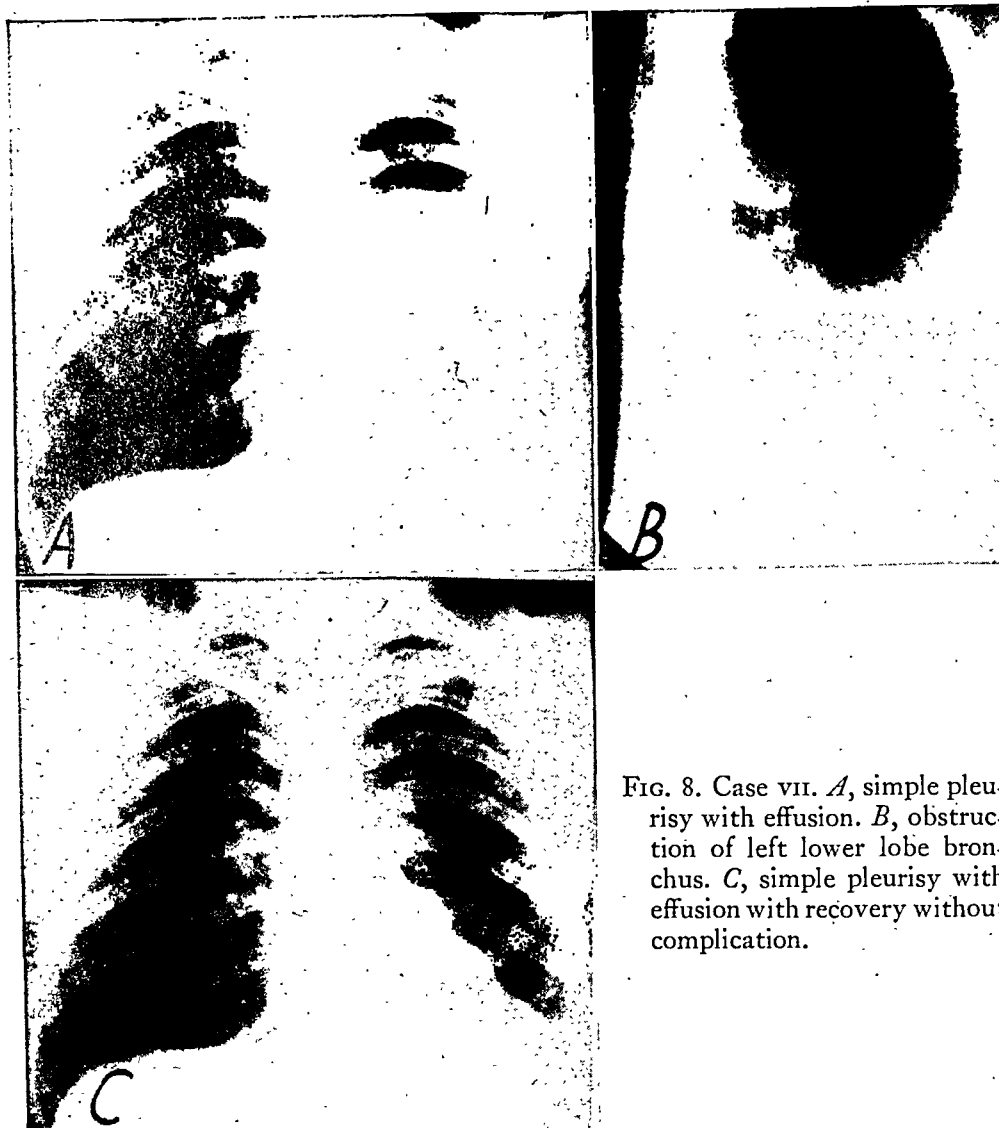


FIG. 8. Case VII. *A*, simple pleurisy with effusion. *B*, obstruction of left lower lobe bronchus. *C*, simple pleurisy with effusion with recovery without complication.



FIG. 9. Case VIII. *A*, infiltrative lesion of right hilum. *B*, calcified hilar node with ulceration into stem bronchus.

such as described above. The planar roentgenographic appearance of mediastinal nodes is shown in a case of metastatic melanoma (Fig. 4*B*).

#### CONCLUSION

Planar roentgenography is a valuable procedure in the study of carcinoma of the lower respiratory tract because it extends

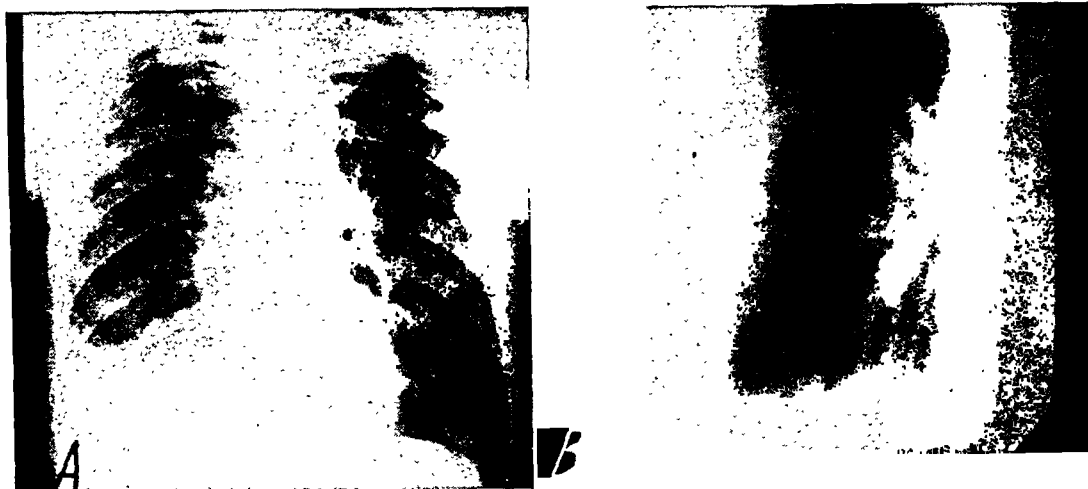


FIG. 10. Case 1x. *A*, diffuse carcinoma of right lower lobe. *B*, diffuse carcinoma of right lower lobe showing bronchiectatic character of lesion.

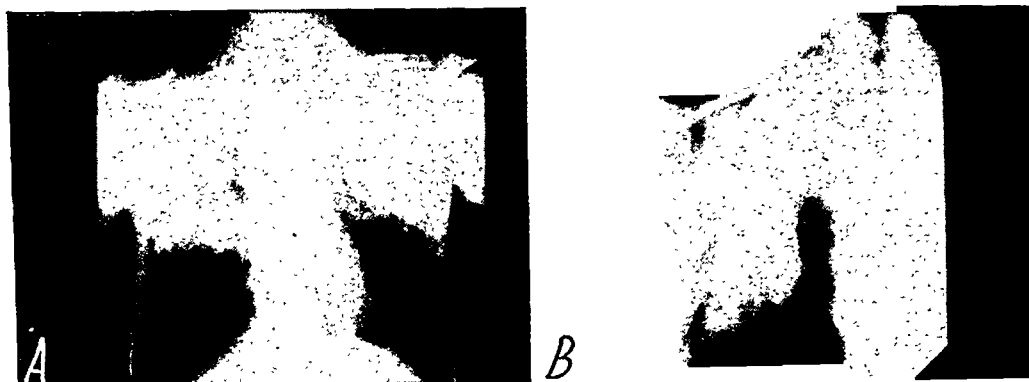


FIG. 11. Case x. *A*, coalescent silicosis. *B*, circumscribed, ball-like character of coalescent lesions in right upper lobe shown in *A*.

the range of usefulness of ordinary roentgenography and makes possible a more complete demonstration of the gross pathologic anatomy of the tumor. Endobronchial tumor, bronchial obstruction and abscess, which otherwise would be undemonstrable, may be visualized.

Planar roentgenography does not, however, differentiate between bronchial obstruction due to endobronchial carcinoma and bronchial obstruction caused or simulated by acute or chronic pneumonic consolidation, non-opaque foreign body, metastatic tumor, pleural effusion or other lesions.

Planar roentgenography will demonstrate but rarely the endobronchial mass of an endobronchial carcinoma. This find-

ing, when present, would, however, be highly pathognomonic in the diagnosis of carcinoma as practically the only lesions to be differentiated are a caseous lymph node ulcerating into a bronchus and an endobronchial adenoma.

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# WAR WOUNDS OF THE CHEST

## ROENTGENOLOGICAL AND SURGICAL CONSIDERATIONS\*

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and

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THE purpose of this communication is to present the roentgen and clinical study of a group of 165 chest casualties received from the Pacific combat zone.

Considerable credit is due the doctors who first attended these men in the battalion aid stations on the beaches, in small boats en route to the transports and hospital ships off shore, and in the sick bays and surgeries of these vessels while en route to base and fleet hospitals far removed from the combat area. Many of these injured were first treated very soon after their injuries occurred, and, as a result, their general clinical condition was most satisfactory upon arrival at our hospital.

### ROENTGENOLOGICAL CONSIDERATIONS

All patients included in this study were examined fluoroscopically and roentgenographically soon after their admission to this hospital. Some of the patients brought with them their films previously made overseas and these were of great help in making comparison and progress studies.

Certain roentgenographic findings were noted in this group and they may be discussed as follows:

(a) *Normal Appearing Chest.* Since some weeks had elapsed between the date of injury and date of admission to our service, a few patients showed complete clearing of previously treated hemothorax. The wounded lung showed complete re-expansion and very little or no fibrosis was noted at the site of the bullet or shrapnel tract. If there had been no record of previous abnormal roentgenographic findings, it would have been difficult to establish the fact that a chest wound had been present.

A few cases of blast injury seen weeks after concussion also showed clear lung fields. Previously reported areas of multiple pulmonary parenchymal hemorrhage had absorbed without residual scarring.

(b) *Thoracic Cage Injury.* Single or multiple rib fractures were noted. Often a spray of metallic particles was seen adjacent to the gunshot fracture of the thoracic cage. We were impressed with the absence of gunshot fractures of the dorsal vertebrae in this group. Such major spine injuries associated with chest wounds probably resulted in death on the battlefield. Very few instances of rib infection were noted and this may be due to the administration of sulfa drugs and penicillin.

(c) *Traumatic Hemothorax.* This is the commonest finding and it may or may not be associated with a pneumothorax. In spite of 50 to 80 per cent compression of the adjacent lung tissue, there often was only a slight shift of the heart and mediastinum to the opposite side. Since most of these patients were treated by multiple aspirations soon after their injury the wounded lung had an early opportunity to expand. There is no definite record of secondary hemorrhage in patients treated by early aspiration of fluid from the pleural cavity with a syringe and needle. The cases which had an infected hemothorax or empyema were more often those which were not treated by early aspiration of the hemorrhagic fluid. There is no roentgenological proof that replacement of air when blood is evacuated from the pleural cavity is advantageous. In fact the air replacement may delay the expansion of the lung and

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FIG. 1. Class I. J. W. Injured on July 26, 1944. Bullet wound. Roentgenogram on September 15, 1944, shows residual fibrous tract in left upper lobe and gunshot fracture of left eighth posterior rib.

leave the pleural cavity more vulnerable to infection, as has been pointed out by Blades in his recent review of chest wounds in the Army. In the chronic cases of hemothorax resulting from clotting, the lung is splinted by the organized clot in the pleura. We have seen no instance of calcification in the chronic hemothorax cases to date. This has been reported by others. The aspirating needle should not be placed too low since it may become plugged with fibrin which has settled to the lower aspect of the cavity. When multiple pockets occur in the pleural cavity as a result of fibrinous adhesions, it may be necessary to treat the patient by open operation.

Chronic fibrothorax has been observed in a number of patients. The roentgenogram of the chest shows evidence of a homogeneous density peripherally with compression of the adjacent lung tissue. On aspiration, little fluid can be obtained and progress roentgenograms reveal no change over a period of weeks.



FIG. 2. Class II. R. C. Injured July, 1944. Through and through gunshot wound of chest. A, roentgenogram on September 11, 1944, shows right hemothorax. Treated by multiple aspirations. B, roentgenogram on January 29, 1945, shows complete clearing. Discharged to full duty.



FIG. 3. Class II. C. W. Injured on July 8, 1944, Retained bullet in right chest. *A*, massive right hemothorax as seen on admission on October 11, 1944, *B*, complete clearing of hemothorax on February 3, 1945, after treatment by multiple needle aspirations. Bullet is seen under right seventh posterior rib. This has been removed.

(d) *Pleural Thickening.* The parietal pleura may remain thickened long after the fluid absorbs or is aspirated from the pleural cavity. This may result in obliteration of the costophrenic angle. Often the lateral third or half of the diaphragm is fixed in an elevated position by adhesions. In the chronic cases the visceral pleura may be markedly thickened and prevent the compressed lung tissue from expanding by fixing the lung. This creates a dead space between the visceral and parietal pleura.

The heart may be retracted by pleuropericardial adhesions or it may remain slightly displaced to the opposite side by adhesions fixing it in position.

(e) *Lung Parenchyma.* Multiple areas of increased density in the lung field representing areas of hemorrhage may be seen soon after blast injuries. These tend to clear completely in time. Massive intrapulmonary hemorrhage may occur after stab wounds or penetrating wounds and this is characterized by a ground-glass homogeneous increased density over the lung field. This also clears completely as the hemorrhage absorbs.

Often one notes little or no parenchymal reaction in the lung about a metallic foreign body when viewed weeks or months after the injury. In through and through bullet wounds of the lungs, there may be an area of increased density spherical or linear in shape about the site of a bullet or shrapnel tract. This may clear leaving little or no fibrosis as a sequela.

(f) *Bullet and Shrapnel Fragments in the Lungs.* The presence of radiopaque metallic fragments is determined roentgenoscopically and their position is marked on the overlying skin with a skin-marking pencil. Metallic markers "A" and "P" are placed on the skin of anterior and posterior chest walls adjacent to the fragment site and stereoscopic posteroanterior roentgenograms are made. A true lateral roentgenogram of the chest is also made. The posteroanterior roentgenogram will establish the position of the fragment in relation to the rib cage and the lateral view will determine its position in relation to the anterior and posterior chest walls. A third roentgenogram taken in the lateral decubitus position, exactly duplicating the position of the



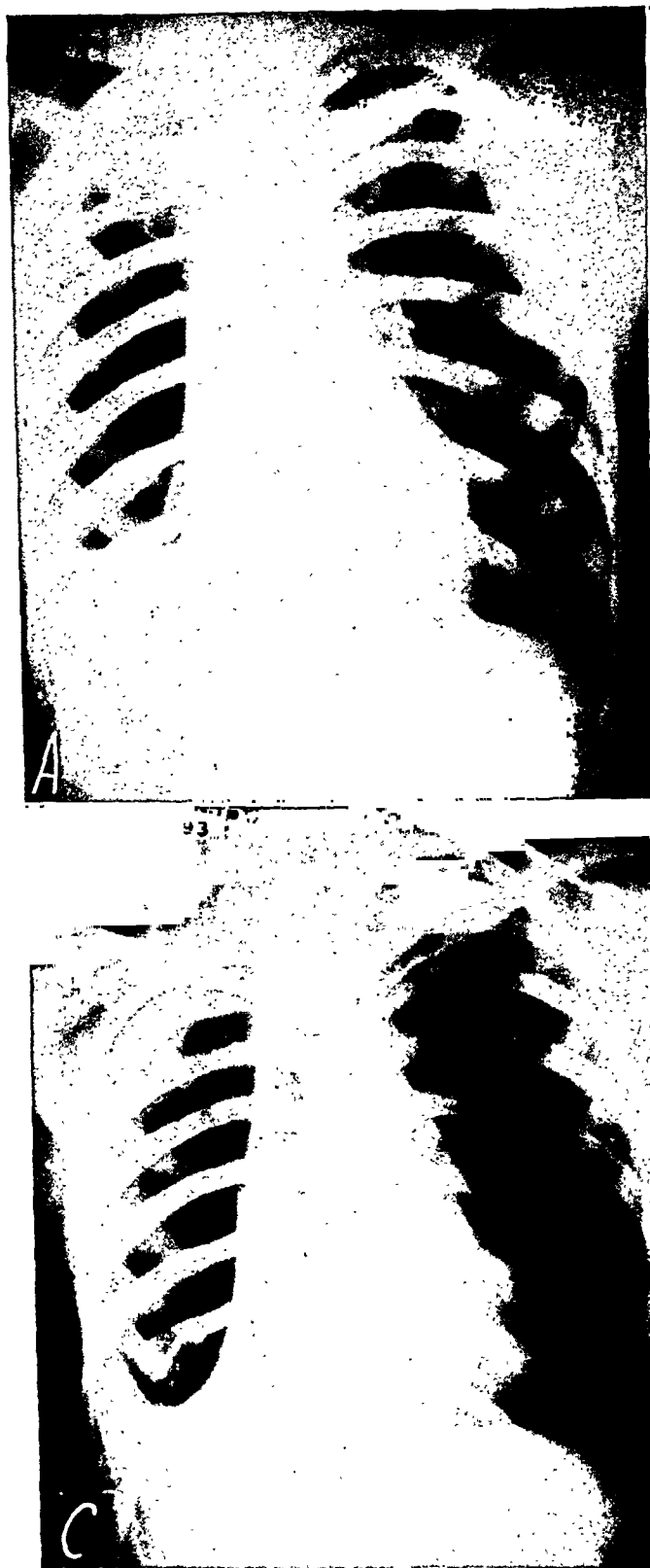
FIG. 4. Class II. B. W. Injured on May 27, 1944. Through and through bullet wound of chest which was not aspirated or drained early. *A*, massive hemothorax right chest as seen on admission July 30, 1944. *B*, chronic hemothorax right chest with multiple fluid levels as

seen in October, 1944. *C*, lateral roentgenogram in October, 1944, shows multiple fluid levels. *D*, lateral decubitus roentgenogram following decortication operation and the introduction of penicillin solution. Single fluid level and pneumothorax are seen. Lung is re-expanding.

patient on the operating table, has been suggested by Blades. This is most important since the position of the ribs in relationship to the foreign body is altered when

the patient is placed on the operating table and the arm is elevated.

The size, shape, position and number of radiopaque fragments is recorded. Many of



B

FIG. 5. Class II. F. L. Injured on July 29, 1944. Shrapnel puncture wound right lung. Hemothorax and early empyema was drained by thoracotomy prior to admission. *A*, roentgenogram on October 26, 1944, shows permanent collapse of the right lung and pyopneumothorax. Note the thick pleural adhesions fixing the right lung. *B*, lateral view on same date as *A* shows fluid level and fragment of shrapnel in the right lung posteriorly. *C*, roentgenogram on February 16, 1945, after first stage thoracoplasty. The thick corset-like pleura is seen to compress the right lung.

our cases showed little or no reaction in the lung tissue surrounding the metallic fragments, in spite of the very large size of some of the foreign bodies. We have observed

evidence of suppuration about some of the fragments, therefore the decision as to the advisability of removal of fragments must be influenced by the fact that late sepsis or



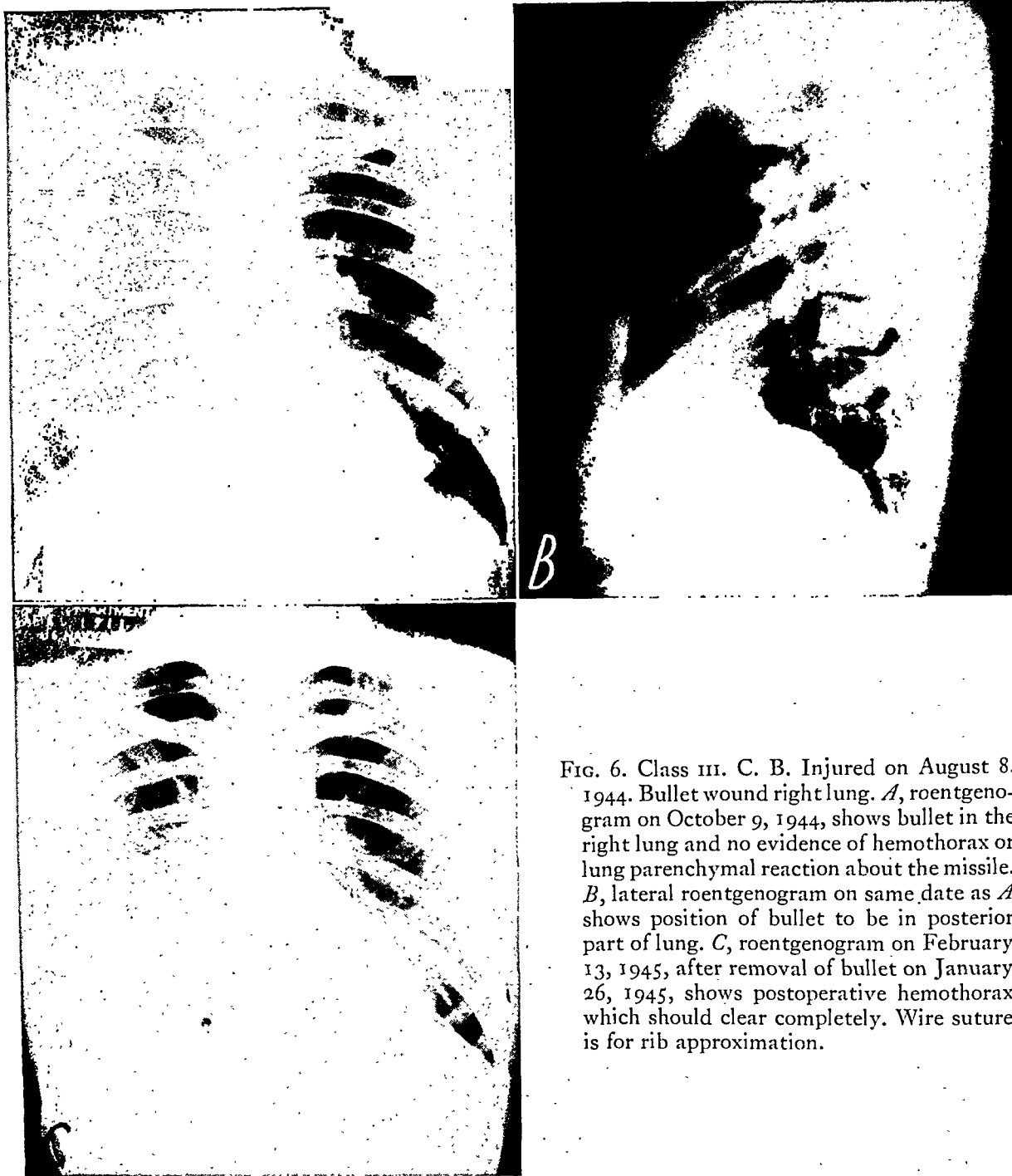


FIG. 6. Class III. C. B. Injured on August 8, 1944. Bullet wound right lung. *A*, roentgenogram on October 9, 1944, shows bullet in the right lung and no evidence of hemothorax or lung parenchymal reaction about the missile. *B*, lateral roentgenogram on same date as *A* shows position of bullet to be in posterior part of lung. *C*, roentgenogram on February 13, 1945, after removal of bullet on January 26, 1945, shows postoperative hemothorax which should clear completely. Wire suture is for rib approximation.

empyema may be expected if they are left in situ.

(g) *Injury to the Diaphragm.* We have observed several cases of diaphragmatic hernia following severe chest injuries. One occurred after a crushing injury to the chest when the patient was run over by a jeep. The other also followed a crushing chest injury when the patient was pinned under a

landing barge. Both patients showed complete retraction of the shreds of the left diaphragm with a large defect in its central portion. The stomach and large and small intestine were seen to move freely into the left side of the thoracic cage when the patient was lowered in the Trendelenburg position while lying supine on the examining roentgenoscopic table. These hernias

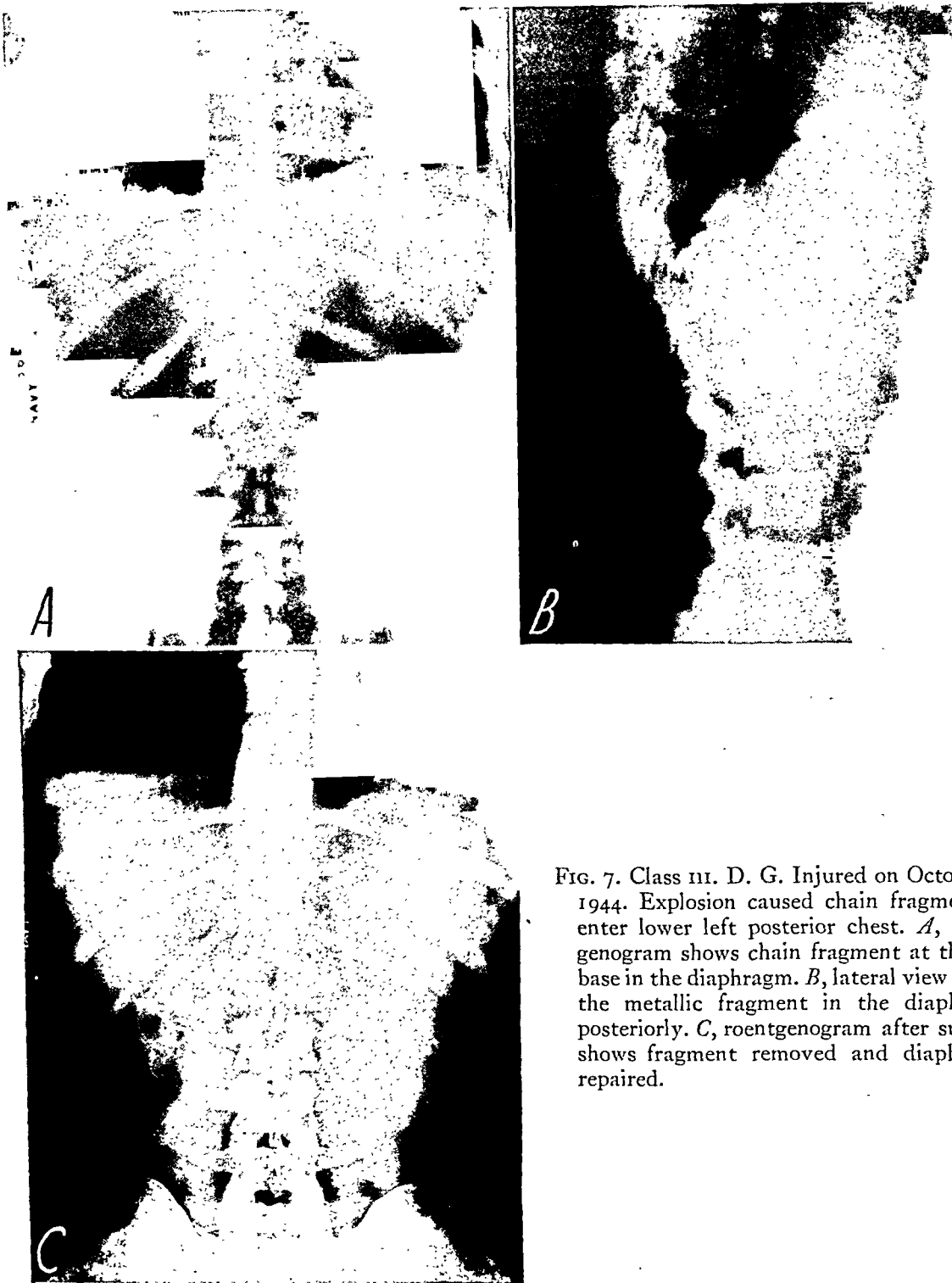


FIG. 7. Class III. D. G. Injured on October 1, 1944. Explosion caused chain fragment to enter lower left posterior chest. *A*, roentgenogram shows chain fragment at the left base in the diaphragm. *B*, lateral view shows the metallic fragment in the diaphragm posteriorly. *C*, roentgenogram after surgery shows fragment removed and diaphragm repaired.

were both repaired surgically and post-operative roentgenograms and roentgenoscopic study showed excellent results.

#### SURGICAL CONSIDERATIONS

These cases have been divided into three classes for the consideration of definitive

care. In Class I are those cases requiring no further treatment; Class II are those requiring treatment of necessity on admission; and Class III are those requiring elective surgery. These injuries were sustained from July through September, 1944.

The group listed as Class I (57 cases) did

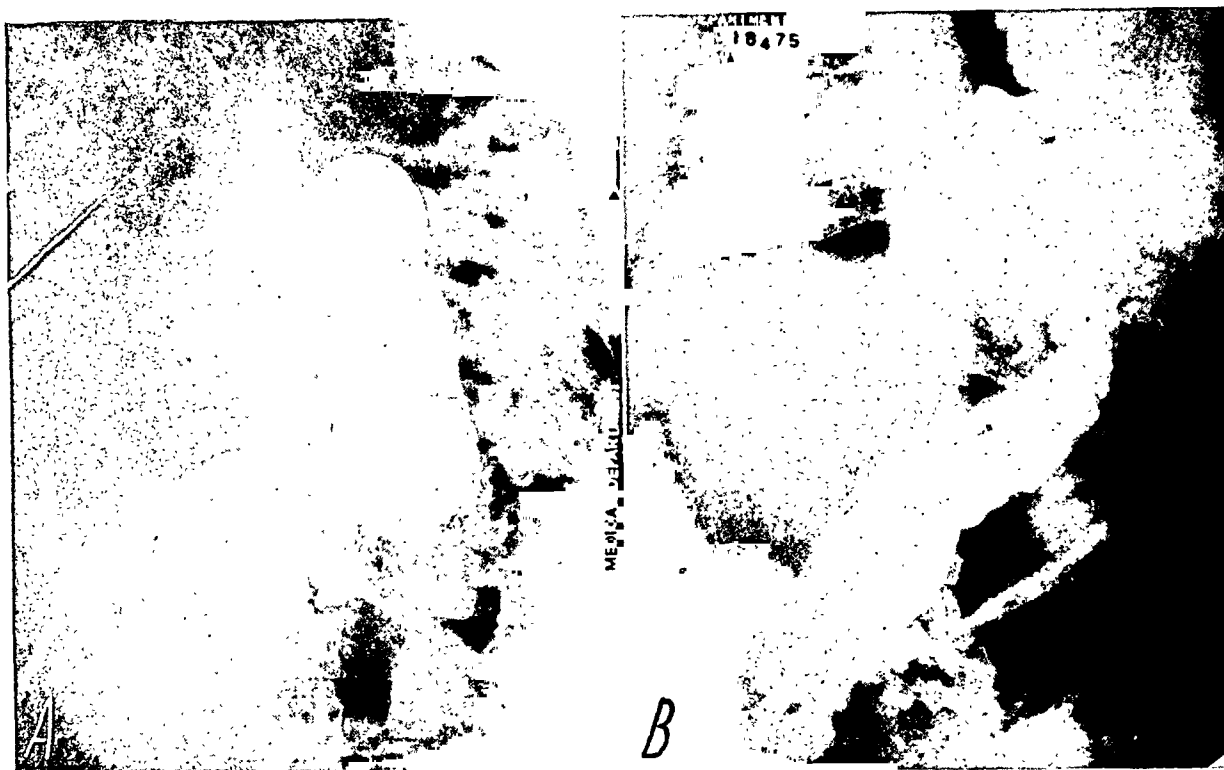


FIG. 8. Class III. E. B. Injured on August 17, 1944, when he was pinned under a landing barge. *A*, roentgenogram of chest after barium meal made with patient in Trendelenburg position. Note shift of the stomach into the left side of the thorax. The cardia was distal to the pylorus when the stomach shifted into the chest. The shadow of the left side of the diaphragm is not visualized. *B*, roentgenogram made after barium enema with patient in the Trendelenburg position shows intrathoracic shift of the bowel through the torn left side of the diaphragm.

not require further treatment after admission to this hospital, having been variously treated by transfusions of blood and plasma, debridement and suture of sucking wounds of the chest, thoracocentesis and foreign body removal at advanced bases. A few of these had small effusions which appeared to be subsiding and were retained on the ward until clearing occurred. There were several with moist granulations filling old chest wall sinuses which soon healed. Thirty-eight of this class had sustained through and through bullet or shell fragment wounds associated with a hemothorax. On admission here, the lung fields were practically normal and the roentgenograms showed no evidence of the previously described hemothorax as recorded in the health records of these patients. One case in this class upon admission had a large open wound,  $1\frac{1}{2}$  inches in diameter, just below the right sternoclavicular junction

with collapse of the upper third of the right lung field and six bronchopleural fistulae which could be seen to emit cigarette smoke when observed with a thoracoscope. This man had received a shell fragment wound of the right chest with subsequent hemothorax and empyema which was drained aboard ship. He became ambulatory soon after admission, and the large, gaping wound in the right upper anterior chest wall began to close. At this time it is entirely healed and the lung has completely re-expanded.

Five combined abdominal-thoracic wounds involving liver, diaphragm and lung were repaired aboard ship immediately after injury and were healed on arrival at our hospital.

Those of Class II (98 cases) required treatment of necessity upon admission or soon after, such as repeated thoracocenteses or some form of surgery.

A few remarks on hemothorax should be made, since the management of this condition seems to be debatable in current traumatic surgery and military literature. Practically all wounds of the chest, penetrating and non-penetrating, sustain a hemothorax of varying degree. In civilian practice it was the teaching to watch and treat conservatively with the hope that the blood would absorb or to aspirate the blood and thus hasten early re-expansion of the lung. Now, since experience gained in North Africa, Italy, in the Pacific, and that of English authors, the conservative regimen has, for the most part, been abandoned, and advocates of early thoracocentesis appear to be in the majority. However, the point of replacing the aspirated blood with air or not is a lively topic of debate. Most wounds which penetrate the pleural cavity allow admission of air before the hemothorax becomes advanced. Likewise, bullet or shrapnel wounds into the lung, including those caused by the entrance and exit of the missile afford a source of air into the pleural cavity via the bronchial route. Thus it would seem that air is already present to set up the clotting mechanism and that the replacement of more air following thoracocentesis would not be a matter of import. The initial amount of air admitted is small, and evidence supports the oft-repeated suggestion that the wounds of the lung quickly seal over by aid of fibrin and tissue debris and possibly with the help of collapse of the lobe and compression from without caused by the blood. Hence, except in the fatally injured, the pneumothorax is not continuous.

Usually, supportive measures for treatment of the shock and a simple dressing to the wounds are the only requisites for the first two to four days. After this time aspiration every forty-eight hours of 500 to 700 cc. of blood, without replacement of air, and using a large No. 15 or 16 gauge needle will control most hemothoraces.

In cases where the source of the blood is not from the lungs but from a large vessel, immediate surgery to ligate the bleeding

vessel must be instituted. This is indicated when, following the first several hours of injury, there are progressive signs of pallor, displacement of the mediastinum and drop of blood pressure.

It is our observation and belief that replacement of air allows a "chronic, clotted hemothorax" to develop. In the old hemothorax cases we received, the fluid obtained via aspiration had a prune juice color, and only a small amount could be obtained even though physical and roentgen examinations of the chest indicated flatness and a massive opaque density. After many attempts to aspirate, enough fluid will be removed so that the roentgenogram will show multilocular pockets with many fluid levels. A major thoracotomy is then indicated to remove the fibrin and fibrous pockets containing the prune juice colored fluid and yellow custard-like clumps of old clotted blood. This is followed by decortication of a very thick pleura which compresses and imprisons the lung in a rigid, corset-like vise.

Of the 165 cases in this study, 136 had hemothorax when first admitted to the sick list. In reviewing the records and taking histories of this group of casualties it was occasionally noted that thoracocenteses were frequently delayed or abandoned because the patient appeared clinically well. The use of sulfa drugs and penicillin may often give a false security and allow a hemothorax to become "chronic" or to progress into an empyema. These wonder drugs cannot perform a thoracocentesis but are only adjuncts to the removal of the fluid.

In these patients the wounds were, for the most part, penetrating in character, there being only 2 with history of concussion injury of the lungs. The type of penetrating injury sustained varied—entrance and exit bullet or shell fragment wounds through the chest wall and lung, entrance and exit injuries with no parenchymal involvement, entrance wounds with retained foreign body fragments of the chest wall only, others involving only the chest

wall and pleura, and others with various sized fragments lodged in skin, ribs, and lung parenchyma. There was only one with foreign body retained in the mediastinum, none in the pericardium or heart, and there were 3 with fragments lodged in the diaphragm muscle.

The Class III group (10 cases) were all elective; for the most part removal of the retained foreign bodies in the chest wall or in the pulmonary parenchyma, and repair of one left diaphragmatic hernia being employed. All of the elective group were given from two to four months after date of injury before surgery was undertaken in order that all possibilities of intrathoracic infection and pleural reaction would be obviated. The diaphragmatic hernia was repaired five months after date of injury, allowing his compound fracture of the right tibia and crushing fractures of the second and third lumbar vertebrae to heal in the meantime.

Removal of the metallic fragments did not present much of a problem. Bullets and large fragments in the lung were removed, since we share the opinion with others that these large pieces of metal will most likely in the near future cause inflammatory and abscess reaction. Many of the cases in this study had metal fragments the size of a pin-head and up to 5 by 10 by 15 mm. These were variously located in the soft tissue or lung and were considered small enough and safe enough to leave alone. A large number of the Class I and II cases have returned to duty with retained fragments.

In the entire study it was surprising to note the small amount of reaction around the retained foreign bodies in just a few months following the injury. The missile tracts healed early, and the hemothoraces and effusions cleared without any complications arising around the retained fragments. This course was noted by clinical improvement and in the appearance of progressive roentgenologic examinations. It has often been mentioned in the literature that many of these foreign body wounds, even though apparently healed

and without demonstrable reaction, could have retained pieces of clothing and other foreign material besides the metal carried into the wound. This is considered to be a source of later infection. Such has been our experience. One large shell fragment 2.5 by 2 cm. removed from the left lung was well encased in fibrous tissue, but upon examination of the removed specimen, small shreds of cloth were easily demonstrated on the metal. Another fragment apparently causing segmental pain and removed from an intercostal space contained a small amount of serous fluid in the fibrous capsule surrounding the metal. This did not communicate with the pleural cavity and the operative wound healed uneventfully.

Just as in World War I, empyema today is a problem of a large number of chest injuries. Many of the Class II cases developed empyema soon after injury. Forty-six cases of this class had empyema prior to admission and had been treated by closed intercostal catheter drainage, open thoracotomy and some by multiple aspiration with re-injection of penicillin. It was necessary to establish an open drainage on 6 of this number after arrival at our hospital. Fifteen of the 46 cases have remained unhealed at this time, having reached the chronic stage and surgery for elimination of the empyema cavity is in progress.

*Results.* Of this entire group, 101 men have been or will be discharged to full duty, 7 to limited duty, while 55 have been or will be invalided from the service.

#### SUMMARY

1. Of a group of 165 cases of war wounds of the chest received from the Pacific combat zone, 57 required no further treatment; 98 required treatment on arrival, while 10 were treated by elective surgery.

2. Hemothoraces should be aspirated early and often without air replacement.

3. In general, large pulmonary metallic foreign bodies are removed and smaller ones, unless multiple, are left in situ and the men returned to duty.

4. Of 136 hemothoraces, 46 developed

empyema; 31 of the latter have healed and 15 have reached the chronic stage.

5. Roentgenological findings are presented in detail.

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# HERNIATION OF GASTRIC MUCOSA INTO THE ESOPHAGUS

## REPORT OF A CASE\*

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**O**BSTRUCTION of the lower third of the esophagus above the cardiac orifice is usually due to a malignant neoplasm. Herniation of the stomach through the hiatus into the thorax is common. The projection of the gastric mucosa into the lower end of the esophagus in such a way as to produce a dilatation of the esophagus and an obstruction simulating a neoplasm is rare. A search of the available literature has failed to disclose a report of this condition.

### CASE REPORT

A man, aged sixty (Unit No. 659924), was admitted first to Presbyterian Hospital in New York City in November, 1941, for substernal pain. His electrocardiogram at that time showed no definite evidence of a coronary occlusion; on further work-up a positive stool guaiac test was noted, and gastrointestinal series revealed a duodenal ulcer. On one roentgen examination in 1941 of the esophagus and stomach, it was noted that "the lower end of the esophagus is somewhat distorted but it may be due to an elongated liver tunnel." A few days later the esophagus was rechecked and described as negative. The patient was discharged on an ambulatory ulcer diet.

In March, 1942, he came in complaining of transitory attacks of substernal pressure and sticking of food at the level of the xiphoid off and on. A repeat gastrointestinal series was done and the esophagus was normal. Pylorospasm and a deformed duodenal bulb were noted. He continued to complain of trouble swallowing, however. In December, 1942, he was admitted with another episode of gastrointestinal bleeding.

In March, 1943, gastrointestinal series again showed a normal esophagus and a deformed irritable duodenal bulb without evidence of a crater. In June, 1943, the patient had his third bleeding episode, and a subtotal gastrectomy with an antecolic gastroenterostomy was performed. He was fairly asymptomatic with no note of substernal pain until August, 1944, when he again was troubled with tightness and discomfort in his chest after swallowing. Sometimes he would be uncomfortable for fifteen to twenty minutes after swallowing and find relief only from vomiting.

He was readmitted here on October 21, 1944, with a history of inability to swallow anything for approximately twenty-four hours. Roentgenoscopy and spot roentgenograms of the esophagus (Fig. 1) showed that the barium



FIG. 1. Two spot roentgenograms taken October 22, 1944, of the lower end of the esophagus showing the rounded filling defect protruding upward into the barium column.

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column was obstructed by a rounded filling defect about 5 cm. above the diaphragm. The esophagus was slightly dilated above this obstruction. The examination was repeated twenty-four hours later with essentially the same findings. A small amount of the barium given the day before had reached the colon. The findings suggested either a cardiospasm with a large piece of meat above the obstruction, or a large neoplasm.

On October 24, 1944, three days after admission, he was esophagoscoped. "About 43 cm. from the upper teeth a fungating mass was seen springing from the left lateral and posterior walls of the esophagus. The lumen of the esophagus was very narrowed, so much so that the suction tube could not be passed. A biopsy was taken from this area." This biopsy showed normal stomach mucous membrane, with the morphology of the glands consistent with that expected in tissue from the area of transition between stomach and esophagus. The esophagoscopy was repeated on October 31, 1944. A No. 9 esophagoscope was passed. "There was a stricture at the level of the diaphragm through which the esophagoscope could not be passed. The stricture was due to a projecting polyp-like mass from which a biopsy was taken. After this the esophagoscope was removed and a No. 7 esophagoscope introduced and the mass previously described was brought completely into view. Another specimen was then taken. The lumen of the esophagus was completely occupied with this projecting mass." This biopsy showed normal mucous membrane of the esophagus in the cardiac portion. On November 6, 1944, the patient was able to swallow ground meat for the first time since the onset of symptoms about sixteen days before. On November 8, 1944, roentgenoscopy and roentgenograms of the esophagus showed no delay in the passage of the barium (Fig. 2). "There was a transient ballooning of the distal portion of the esophagus which seemed to be quite flexible and would not retain barium for any degree of time. I believe there is a slight herniation of the stomach through the hiatus and there is a short esophagus." The patient was discharged and has been seen frequently in the clinic since. He was seen last in December, 1945, over a year after his acute episode, and at that time he had no complaints except occasional belching.

#### COMMENT

A case of esophageal obstruction lasting



Fig. 2. Two spot roentgenograms of lower end of the esophagus taken November 8, 1944, showing no obstruction.

about sixteen days, and demonstrated both by the roentgen ray and two esophagoscopies, is presented. Two biopsies of the mass seen obstructing the lower end of the esophagus about 5 cm. above the level of the diaphragm showed normal mucous membrane of, on one occasion, stomach, and the other, esophagus, both near the cardia. Subsequent examination suggested a small hiatus hernia. The only suggestion that we can offer is that this man's swallowing symptoms were related to his hernia, that, as he stated in the history, he occasionally vomited to relieve his symptoms, and that he had strained sufficiently to herniate his stomach into the lower end of his esophagus.

#### SUMMARY

A case of esophageal obstruction due to herniation of gastric mucosa into the esophagus is presented.

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# RIGHT-SIDED THORACIC STOMACH

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**R**IGHT-SIDED thoracic stomach is a rare anomaly. Only about 5 per cent of diaphragmatic hernias are right sided, and the majority of these do not contain stomach. Right-sided hernias are mostly of the parasternal type (via the foramen of Morgagni) and, according to Ritvo and Peterson,<sup>1</sup> never contain stomach or duodenum. The right parasternal hernial contents are most frequently the omentum and the transverse colon. Less commonly, ascending colon, cecum, appendix, and terminal ileum may be found.<sup>1</sup>

The following are reports of 6 cases of right-sided thoracic stomach seen within the last year at Jefferson Hospital, Philadelphia, Pennsylvania, and the United

States Public Health Service Dispensary, Washington, D.C.

## REPORT OF CASES

**CASE 1.** G. L. O., white female, aged twenty, has always been well except for minor digestive disturbances. Since childhood, she has noted fullness in the epigastrium immediately after eating, which would disappear in thirty to sixty minutes. Heart burn often appeared shortly after eating, but this could be avoided by small meals at frequent intervals. As a result, she has always followed a regimen of frequent small meals, and has never consulted a physician about the distress. Except for pertussis at nineteen months, the past history was irrelevant.

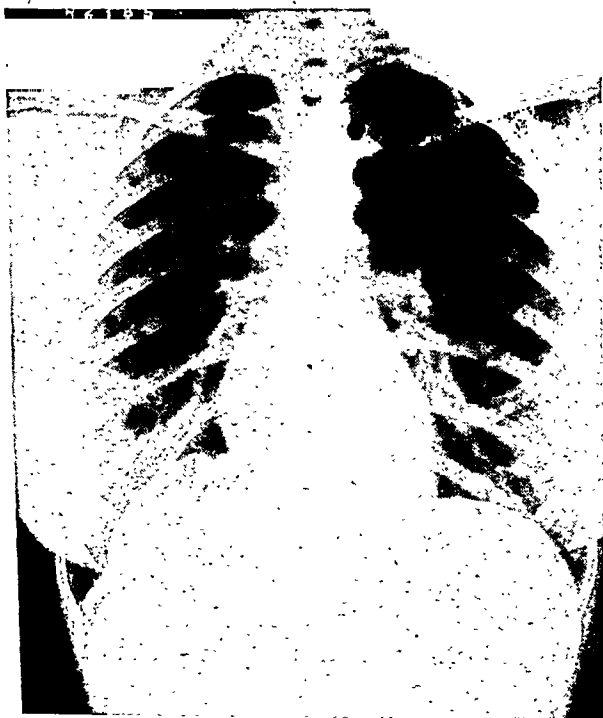


FIG. 1. Case 1.



FIG. 2. Case 1.

A 35 mm. photofluorographic film, made routinely on all civil service applicants, revealed a rounded density in the right lower chest, containing some vague gas shadows. Follow-up studies showed the bulk of the stomach in the right chest, with the antrum passing through the esophageal hiatus into the abdomen. The duodenal bulb was in its normal position. The esophagus turned to the right at



FIG. 3. Case I.

the level of the seventh dorsal body, going directly to the gastric fundus. Postural changes produced little change in the position of the stomach (Fig. 1, 2 and 3).

CASE II. P. F., female, white, aged twenty, in the course of routine chest 35 mm. film, was found to have a rounded mass in the right lower chest, with an air and fluid level. Further studies with barium revealed the stomach in the right lower chest, with the fundus posterior, and the antrum well anterior. The pylorus dipped into the abdomen about half way between the spine and the anterior abdominal wall. No right diaphragm could be identified on the films, or roentgenoscopically. It was felt that a good portion of the right diaphragm was absent. Other gas shadows were seen below the

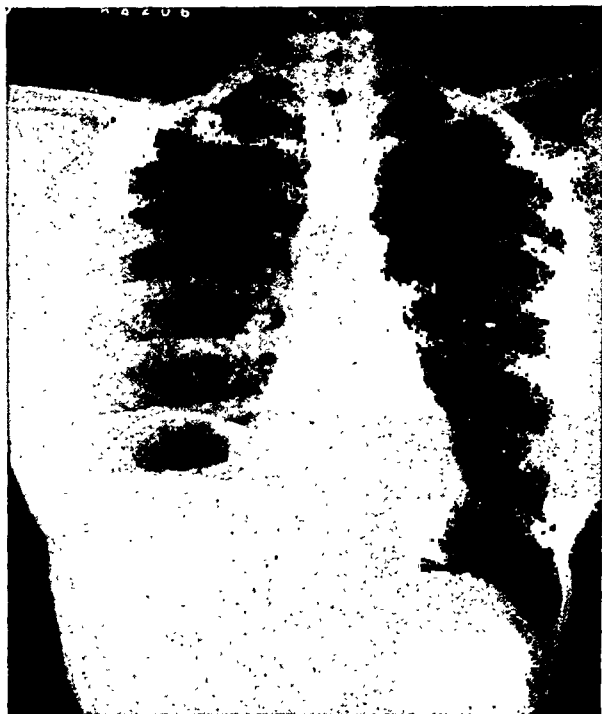


FIG. 4. Case II.

stomach on the right, but the patient refused further study. The esophagus was shortened, and deviated posteriorly and to the right at the

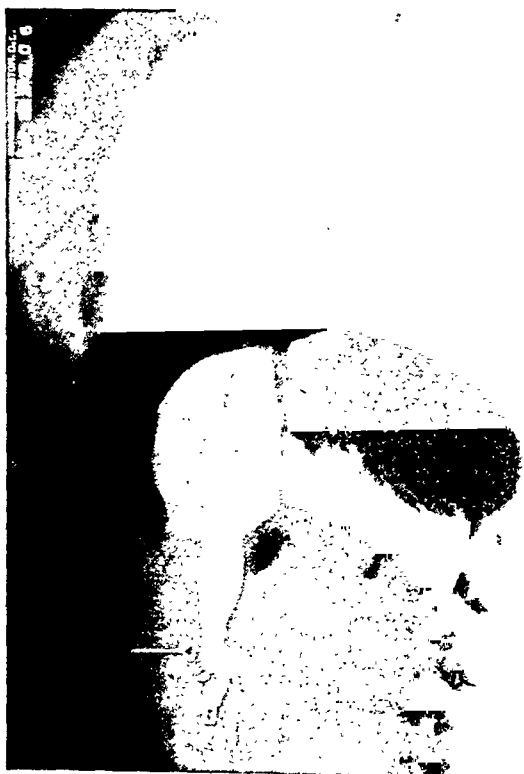


FIG. 5. Case II.



FIG. 6. Case II.

level of the 8th dorsal body, directly entering the displaced fundus (Fig. 4, 5 and 6).

The patient had been aware of the anomalous position of the stomach. This was discovered

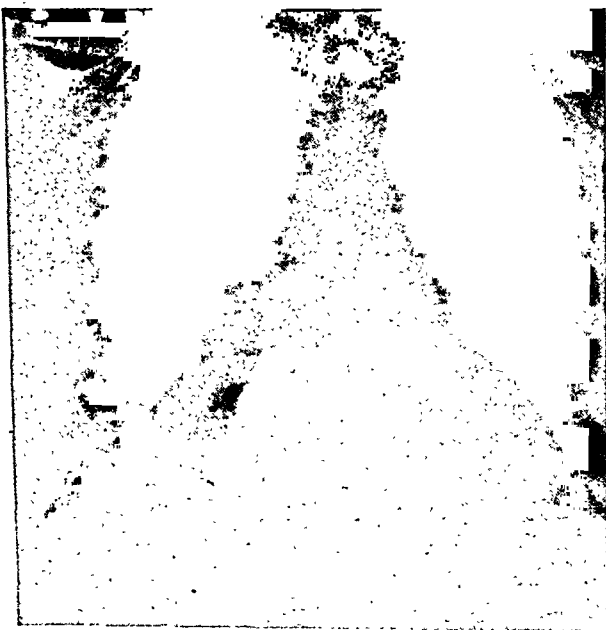


FIG. 7. Case III.

when she was three weeks old, and she had been vomiting persistently since birth. Throughout childhood, she was subject to frequent vomiting, usually directly after a full meal. Small and frequent feedings prevented this digestive disturbance, although some epigastric fullness and hiccoughing still often occurs after eating, but lasts only a few minutes.

CASE III. A. P., male, white, aged sixty-four, has been in excellent health. Since childhood, occasional attacks of "bloating" have occurred after a heavy meal, but never severe enough to

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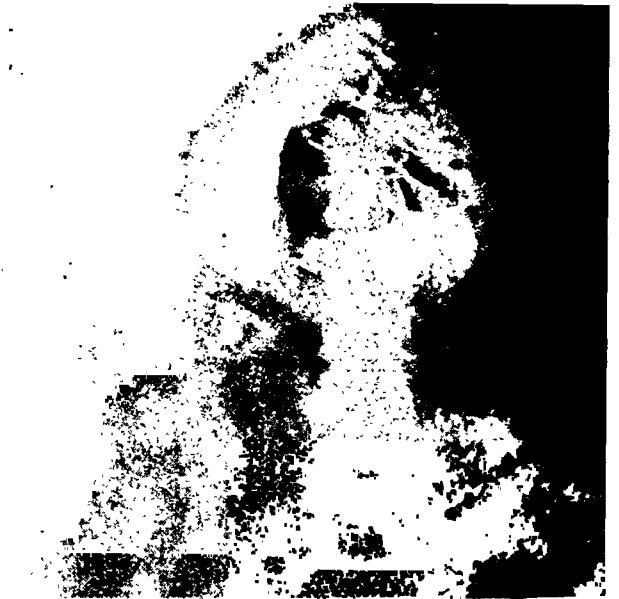


FIG. 8. Case III.

cause him to consult a physician. This distention is relieved by belching.

A 4 by 5 inch chest roentgenogram made in the course of an industrial survey revealed a large collection of gas overlying a fluid level in the right lower chest, adjacent to the heart. No gas bubble could be seen under the left diaphragm. The possibility of a right-sided thoracic stomach was suggested and confirmed by oral barium studies (Fig. 7, 8 and 9).

The entire stomach was in the right chest. The fundus was in the midline and the antrum to the right and slightly posterior, giving the viscus the appearance of an inverted horse-

shoe. The esophagus deviated from its usual course at the level of the seventh dorsal vertebra and emptied into the fundus slightly posterior and lateral to the midline. The antrum passed through the esophageal hiatus, emptying into the duodenum immediately beneath the diaphragm. The remainder of the intestinal tract was normal. The position of the stomach was not altered by posture. The right diaphragm moved freely on respiration.



FIG. 9. Case III.

CASE IV. A man, white, aged thirty-four, was admitted to the hospital because of gynecomastia associated with Fröhlich's syndrome. There were no gastrointestinal complaints. On the routine preoperative chest roentgenogram was seen a rounded mass of homogeneous density adjacent to the right cardiac border. No gas bubble could be seen under the left diaphragm. The possibility of right-sided thoracic stomach was suggested and confirmed by gastrointestinal study (Fig. 10, 11 and 12).

The esophagus deviated from its usual course at the level of the sixth dorsal vertebra, passed far to the right of the midline and directly entered the fundus of the stomach from the right side. The stomach then passed obliquely downward to the left with its upper half above

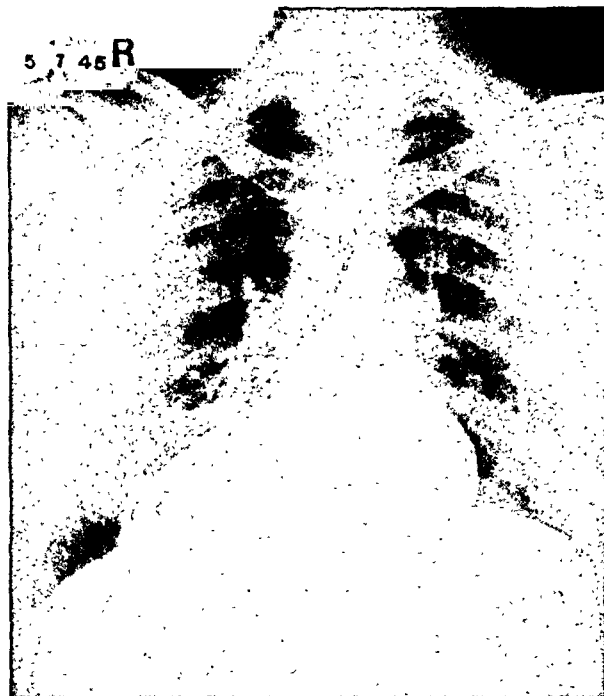


FIG. 10. Case IV.

the right diaphragm, its mid-portion passing through the diaphragm, and its lower half



FIG. 11. Case IV.

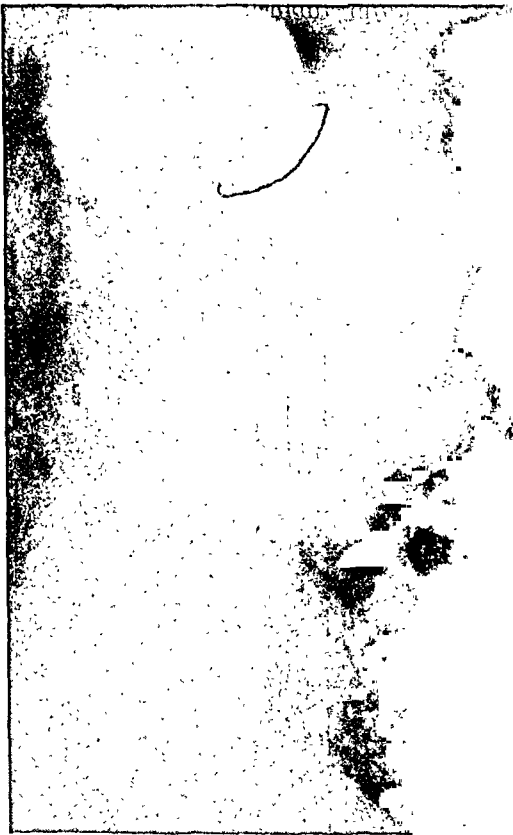


FIG. 12. Case IV.

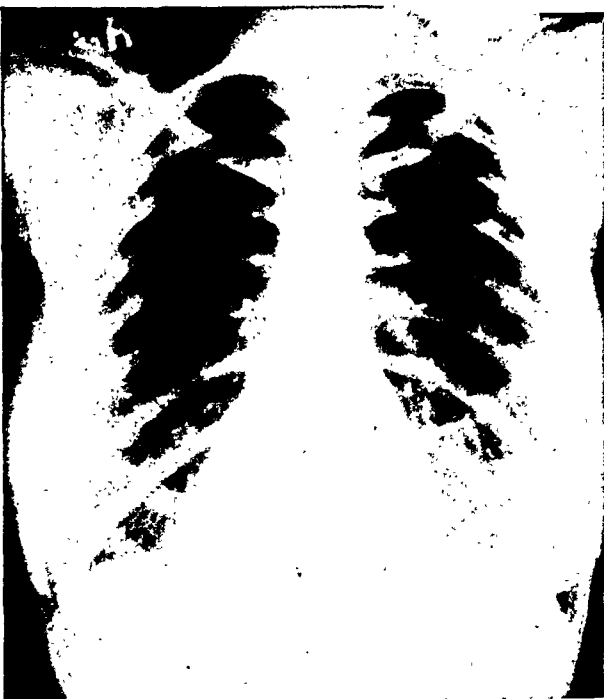


FIG. 13. Case V.



FIG. 14. Case V.

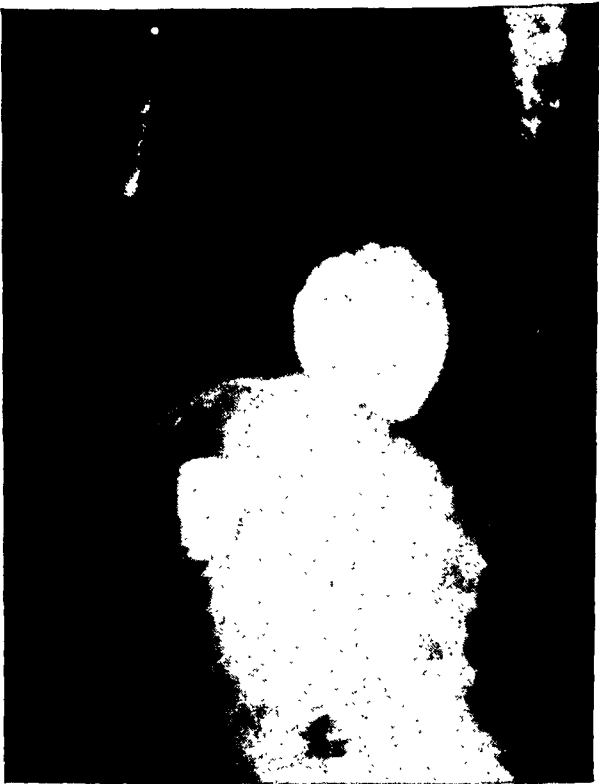


FIG. 15. Case V.

lying in the abdomen. There was no obstruction to the flow of barium. When the patient was in the recumbent position the barium fluctuated between the fundus and antrum with respiration. The duodenum was in its normal position. The stomach emptied readily and the remainder of the gastrointestinal tract was normal.

**CASE V.** In the course of a routine miniature chest film of this thirty year old white woman, a density was seen in the right cardiophrenic angle, with a linear edge and with vague gas shadows within the density. No gastric gas bubble was present. The suspicion of right-sided thoracic stomach was confirmed by barium study (Fig. 13, 14 and 15).

The entire fundus was in the right chest, close to the midline on the anteroposterior view, assuming a "C" shape. The esophagus entered the upper edge of the "C", and was apparently shorter than normal. The lower limb of the "C" passed through the esophageal hiatus, and the remaining portion of the stomach was normally situated beneath the left diaphragm. The duodenum and remaining portions of the intestinal tract were normal.

No gastrointestinal complaints were elicited from the patient, nor were there any significant facts in her past history.

**CASE VI.** This forty-six year old white man

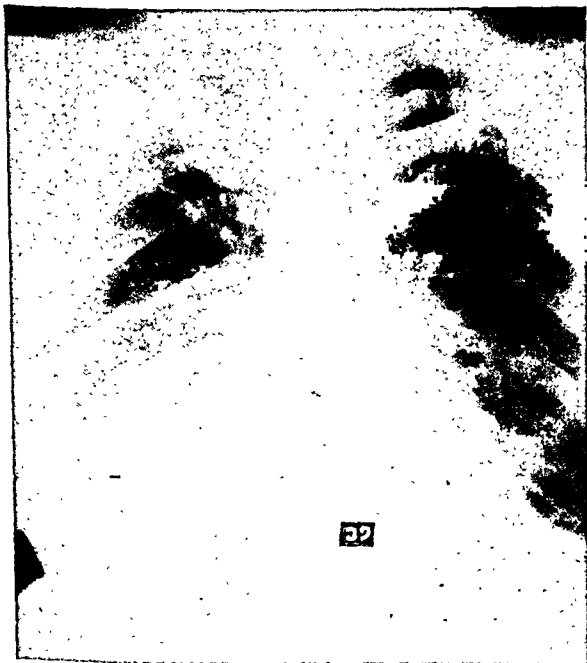


FIG. 16. Case VI.

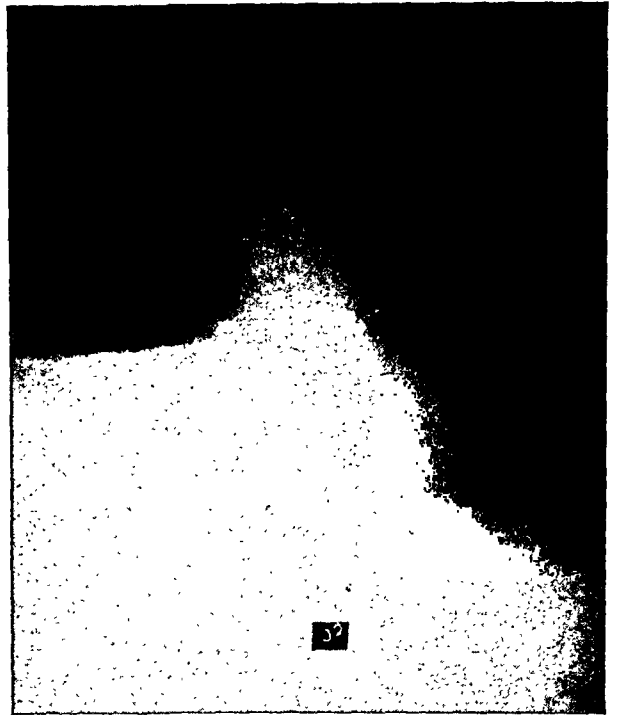


FIG. 17. Case VI.

was not seen or examined by either of us, but his roentgenograms found in a previous survey collection. The only history obtainable was the surprising paucity of gastrointestinal complaints. The chest roentgenogram revealed a large semicircular density in the right lower chest, with an air and fluid level. The usual gas bubble beneath the left diaphragm was absent. Barium studies proved this mass to be the entire stomach in the right lower chest, with the duodenum in its normal abdominal position. No lateral views were available to indicate through which portion of the diaphragm the stomach passed (Fig. 16 and 17).

A good working classification of diaphragmatic hernias was given by Harrington<sup>2</sup> and by Ritvo and Peterson.<sup>1</sup> Cases are divided into the non-traumatic and the traumatic types, as follows:

A. Non-traumatic

I. Congenital

- a. Through esophageal hiatus
- b. Through pleuroperitoneal foramen of Bochdalek
- c. Through absent or defect in dome of diaphragm
- d. Through foramen of Morgagni (parasternal hernia)

2. Acquired
  - a. Through esophageal hiatus
  - b. Through pleuroperitoneal foramen
  - c. Through foramen of Morgagni
- B. Traumatic—commonest through the posterior portion of the diaphragm

The acquired non-traumatic types are thought to result from normal increases in intra-abdominal pressure (as coughing, lifting, etc.), associated with congenitally weak or enlarged foramina. Hernias through the foramen of Bochdalek are uncommon in adults. In infants these herniations are often massive and fatal. The parasternal hernias are usually on the right side, but practically never contain stomach.<sup>1</sup>

All our reported cases are of the non-traumatic type. Case II was undoubtedly of congenital origin, with an absent or poorly developed right diaphragm; diagnosis was made at three weeks of age. Four of the cases showed the esophageal hiatus to be the site of "herniation." It is impossible to be certain whether these are congenital or acquired. The history and absence of gastric mobility favors a congenital etiology. Data are inadequate in the sixth patient.

The clinical findings in these patients were surprisingly few. The mild indigestion, mainly epigastric fullness for a short time after meals, was not severe or progressive; the patients felt no need for medical advice. In 3 of the patients there were no gastrointestinal symptoms. It is of interest that our patient with the absent or poorly developed right diaphragm was subject to attacks of hiccoughing immediately after large meals.

The roentgen diagnosis of right-sided thoracic stomach by oral barium study requires no comment. It is, however, important to suspect this diagnosis on roentgenograms of the chest where a rounded density appears at the right base and where there is no gastric air bubble under the left diaphragm. All the reported cases were

uncovered through routine roentgenograms of the chest; 5 of these were miniature posteroanterior chest films made in surveys.

Where there is an air-fluid level in the density, lung abscess or infected air cyst will enter the differential diagnosis, Neoplastic disease may be considered where the density appears more homogeneous. In Case IV only was gas completely absent on the original chest roentgenogram. The density at the right base showed air-fluid level in 3 of our patients; in the other 2, gas shadows without fluid levels were found.

Neither medical nor surgical treatment was necessary in any of the patients, in view of the minimal and non-progressive nature of the symptoms.

#### SUMMARY

1. Six cases of right-sided thoracic stomach in adults are reported. All were of the non-traumatic type, and most were probably of congenital origin. In four cases the stomach passed through the esophageal hiatus; in one patient the right diaphragm was absent or poorly developed.

2. None of the patients had severe or progressive gastrointestinal symptoms. Three had had mild symptoms since childhood, while three were completely asymptomatic.

3. In all cases the diagnosis was suspected from routine roentgenograms of the chest (five were miniature chest films in surveys). A rounded density in the right lower chest, with or without gas shadows, and absence of the gastric gas bubble under the left diaphragm were characteristic findings in all the chest roentgenograms.

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# COMMON PECULIARITIES OF PATIENTS WITH ADENOCARCINOMA OF THE ENDOMETRIUM\*

WITH SPECIAL REFERENCE TO OBESITY, BODY BUILD,  
DIABETES AND HYPERTENSION

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CERTAIN coincidental factors in carcinoma of the endometrium have been widely noticed and recorded. Others have been mentioned only incidentally. This work is based on a review of the literature and a detailed study of 23 consecutive cases of carcinoma of the endometrium admitted to The Ellis Fischel State Cancer Hospital during 1944 and 1945. Our purpose is to emphasize the peculiarities which are common to these patients and, in particular, the frequency among them of diabetes, obesity and hypertension. We have made a study of the body build of these patients and, in addition, in each case the laboratory investigations included basal metabolic rate, glucose tolerance tests, and blood cholesterol. The presence of adenocarcinoma of the endometrium was confirmed by biopsy in every case.

*Age.* The average age of our patients was 61.2 years, while the literature reports the highest incidence in the sixth and seventh decades. This is about one decade higher than the average age of cases of carcinoma of the cervix. The distribution of cases in the various decades is shown in Figure 1.

*Race.* Scheffey, Thudium and Farrell<sup>29</sup> found a higher incidence of carcinoma of the endometrium in Jewish women than in Gentile women. No other racial differences have been noted. Our small series does not allow such a differentiation.

*Parity.* Unlike carcinoma of the cervix, carcinoma of the endometrium is not related to parity. Of the 23 patients in our series, 20 were married. The average number of children among the entire group was 1.5. Ten of these patients were nulliparous.

Scheffey, Thudium and Farrell<sup>29</sup> found 35 per cent of their series nulliparous, and Healy and Brown<sup>11</sup> reported 36 per cent.

*Menopause.* Carcinoma of the endometrium occurs more often after the menopause. This was found to be true in all series reviewed. However, it may not be as

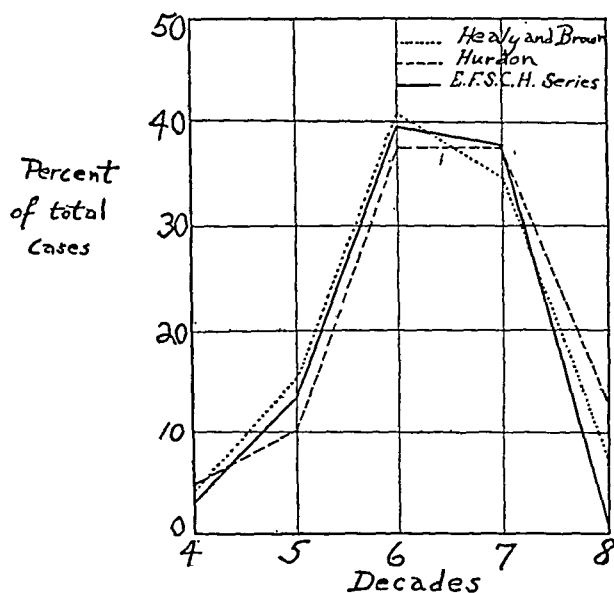


FIG. 1. Percentage of cases of cancer of the endometrium at different ages.

markedly postmenopausal as anticipated. There is much evidence that the menopause may be delayed in the average case of endometrial carcinoma. The frequency of late menopause in carcinoma of the endometrium is pointed out in Table 1.<sup>3</sup> Although Randall<sup>26</sup> also found this to be true, Mason and Gregg<sup>21</sup> and Taylor and Millen<sup>36</sup> did not encounter this relationship. In these cases, irregular vaginal bleeding occurring after the menopause may very well be a

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result of the malignancy and may be misinterpreted by the patient as being a continuation of normal menses. For this reason, in cases of carcinoma of the endometrium it is very easy to obtain a false history of delayed menopause. Crossen and Hobbs<sup>3</sup> feel, although they have no figures to prove it, that cases of late menopause

TABLE I  
AGE AT THE MENOPAUSE  
(CROSSEN AND HOBBS<sup>3</sup>)

Age of Menopause	Fundus Carcinoma 56 cases	Normal 2,291
36-40	2%	12%
40-45	4%	26%
45-50	30%	41%
50-55	60%	15%

have a higher incidence of cancer of the endometrium than those of early menopause. Apparently, however, there is a little difference in the age of onset of the menses in patients with carcinoma of the endometrium. One hundred consecutive women admitted to The Ellis Fischel State Cancer Hospital with postmenopausal diseases unrelated to the female genital system had their menarche at an average age of fourteen years and their menopause at an average age of forty-seven years. This is an average of thirty-three years menstruation. The 23 patients with endometrial carcinoma had their menarche at an average age of twelve, their menopause at an average age of forty-nine, and menstruated for an average of thirty-seven years. With the small number of cases involved, this difference is of questionable significance.

*Leiomyomas.* The literature contains many reports regarding the frequency of leiomyomas of the uterus coincident with carcinoma of the endometrium. Healy and Brown,<sup>11</sup> 38 per cent; Stacy,<sup>32</sup> 33.4 per cent; Morrin,<sup>22</sup> 35.2 per cent; and Scheffey, Thudium and Farell,<sup>29</sup> 37.8 per cent. In our series the incidence of leiomyomas was 44

per cent. Our figure was obtained from surgically removed uteri only, and all sizes of leiomyomas were included.

The frequency of leiomyomas of the uterus is not available from the literature. Frank,<sup>9</sup> in reviewing the work of Klob, reported that 40 per cent of all women over fifty years of age have uterine leiomyomas. Randall<sup>26</sup> found that of 729 patients over forty suffering from abnormal vaginal bleeding, 50.9 per cent had grossly palpable leiomyomas. He found an incidence of 2.12 per cent of endometrial carcinoma in those with uterine myomas, and an incidence of 2.43 per cent endometrial carcinoma in those without leiomyomas. From these figures, it seems evident that leiomyomas of the uterus do not necessarily predispose to the development of endometrial carcinoma. Warton<sup>38</sup> has emphasized that leiomyomas are dependent upon ovarian stimulation.

*Estrogenic Stimulation.* The etiologic significance of estrogenic stimulation in carcinoma of the endometrium is by no means settled. As TeLinde<sup>37</sup> has pointed out, contradictory reports have been published because of the difference in the interpretation of what constituted the minimum histopathologic changes necessary for making a diagnosis of hyperplasia. Novak and Yui<sup>24</sup> thought that postmenopausal hyperplasia predisposed to endometrial carcinoma, but more recently, Fahlund and Broders<sup>8</sup> failed to confirm this relationship. The latter not only reviewed the literature on this subject but studied 236 postmenopausal uteri, of which 86 contained adenocarcinoma. They reported a higher incidence of atrophic endometrium and fewer cystic changes in adenocarcinomatous uteri than in non-carcinomatous uteri.

Studies of the ovaries in endometrial carcinoma have failed to reveal any significant consistent ovarian abnormalities. Jones and Brewer<sup>17</sup> studied the ovaries and endometriums of 68 cases and found cysts of the ovaries and cystic glandular hyperplasia to be unrelated to carcinoma of the endometrium. Geist and Salmon<sup>10</sup> used large doses of estrogen over long periods of time with-

out evidence of abnormal proliferation of endometrium. Jones and Brewer<sup>17</sup> also cited experimental work on the rat, guinea pig, mouse, rabbit, and monkey, which despite relatively large doses of estrogen for long periods of time have alone failed to produce any evidence of endometrial carcinoma. These facts suggest that hyperestrinism or the unopposed action of estrin has little if any etiologic importance in carcinoma of the endometrium. A statement which does not support this thesis has been made by Herrell,<sup>12</sup> who found no case in his own series or in the literature in which carcinoma of the endometrium developed following surgical castration. However, in 1941, Smith<sup>31</sup> reported 3 cases of carcinoma of the endometrium occurring at least fifteen years following bilateral oophorectomy.

Estrin-secreting ovarian tumors are not infrequently accompanied by endometrial carcinoma. Hodgson, Dockerty and Mussey<sup>13</sup> reported 62 cases of granulosa cell tumor, of which 8 (12.9 per cent) had coincident carcinoma of the uterine fundus. Dockerty<sup>7</sup> previously reported an incidence of 10 per cent of carcinoma of the endometrium in 32 cases. Banner and Dockerty<sup>1</sup> in reviewing 23 cases of theca cell tumors of the ovary, found 4 cases (22 per cent) of concomitant endometrial carcinoma, while Dockerty<sup>7</sup> found only 1 out of 10 cases of theca cell tumor.

Unique is Case 2 of Stohr's<sup>33</sup> in which a patient with coincidental granulosa cell tumor and endometrial carcinoma (diagnosed by curettage) had the involved ovary removed. Six weeks later, the menses were normal and a second curettage revealed a normal endometrium. No recurrence was evident after five years.

Other than the rare coincidental granulosa or theca cell tumors of the ovary, no significant ovarian abnormalities have been reported in fundal carcinoma. In most cases, as shown by Jones and Brewer<sup>17</sup> and Ingraham, Black and Rutledge,<sup>15</sup> the ovaries are either normal or are found partially or completely atrophic. The bulk of evi-

dence favors the work of Jones and Brewer; and it would seem, as they point out, that normally functioning ovaries cannot be shown to produce carcinoma of the endometrium and that hyperestrinism or the unopposed action of estrin is not responsible for such development in the great majority of cases. Certainly this relationship should be studied more carefully before estrogen can be accused of being even an occasional carcinogen.

#### BODY TYPES

In certain body types or builds, gastroduodenal ulcers and thyrotoxicosis are found; while in other builds cardiovascular disorders, nephritis, diabetes, gallbladder abnormalities, and cirrhosis of the liver are found.<sup>27</sup> As Robinson<sup>27</sup> has pointed out, this association does not imply that it is the build which produces the selectivity of the disease. Rather, "the build is the gross morphological expression of a deep-seated 'genotypic' change of the neuroendocrine system and the biochemical reactions of the entire body."

Tannebaum<sup>34</sup> has reported a correlation between caloric intake and tumor incidence in mice. He compared groups of mice fed diets varying only in carbohydrate content. The incidences of spontaneous breast tumors, chemically produced carcinomas of the skin, and chemically produced sarcomas were studied. Animals receiving the calorie-restricted diet showed a decrease in the total number of each type of tumor and a delay in their time of appearance. By analyzing the statistics of life insurance companies Tannenbaum<sup>35</sup> has found that overweight persons past middle age are more likely to die of cancer than are persons of average weight. However, he points out that the relationship between cancer and body weight is not necessarily a direct one: "It may be, and in uncompleted experimental work there is evidence for it, that some of the factors controlling weight are of more direct significance than weight itself, the latter being merely a resultant of these forces."

*Obesity* has been noted as a frequent complication of carcinoma of the endometrium, but it has usually been referred to only as a factor hindering operability. Thus Scheffey and Thudium<sup>28</sup> mentioned it, but not its frequency. Frank<sup>8a</sup> mentioned that 35 per cent of his patients were obese, but did not state what constituted obesity. Morrin and Max<sup>23</sup> noted "a high percentage of obese females," and Smith<sup>31</sup> noted that 28 per cent weighed 160 pounds or over. Corscaden<sup>4</sup> stated that "There is a large number of these females who have small hands and

build, 2 of linear intermediate build, 3 of lateral intermediate build, and 15 of lateral build.

The ponderal index was calculated for each individual, using the formula:

$$\frac{\text{weight} \times 100}{\text{height} \times \text{chest circumference}}$$

As Robinson has pointed out, this modified ponderal index adjusts for height and width, allowing the taller or broader person to carry more weight and the shorter or more slender person to carry less weight and be classified as normal. Thus, 16 of our patients were heavyweights; 6 were mediumweights; and 1, lightweight.

The great majority of patients with endometrial carcinoma are of the lateral build, heavyweight type (Table II). Fourteen of our patients (61 per cent) showed both of these characteristics. Body build is determined by three and possibly four separate genetic factors.<sup>6</sup> Sheldon, Stevens and Tucker<sup>30</sup> suggest that endocrine function may play some role in determining body type but its relative importance is unknown. They ask the question. "Is the problem of interbalancing of the internal secretions and of the relative dominance of different endocrine elements in the body rather a reflection than a cause of a deeper and more general balancing of constitutional components?"

*Diabetes.* Diabetes has been mentioned in the literature just as has obesity; namely, as a factor producing inoperability. Scheffey and Thudium<sup>28</sup> report 11 per cent diabetes in their series, and comment on it as follows: "The association between diabetes and carcinoma of the endometrium is not surprising when we consider that the obesity present in so many patients may predispose to, or be associated with the former disease." Marble<sup>20</sup> reviewed 256 cases of malignant diseases of all types in which diabetes was known to be present. He found 33 carcinomas of the uterus in 151 females, an incidence of 22 per cent (carcinoma of the cervix and endometrium were not recorded separately). Carcinoma of the cervix and endometrium together make up about

TABLE II  
BODY BUILD

	Linear	Linear Intermediate	Lateral Intermediate	Lateral
Light 6.00	1			
Medium 6.99	2	2	1	1
Heavy			2	14
PI	0.54	0.59	0.60	

feet and large hips." He suspected these abnormalities were manifestations of endocrine disturbances.

In our series of 23 patients, the average weight was 187 pounds, and, by using a standard table of average normal weights based on age and height alone, 17 were 10 per cent or more above average normal weight; 4 were of normal average weight, and 2 were 10 per cent or more below average normal weight. The more detailed method of determining and recording body types (somatotyping described by Sheldon, Stevens and Tucker<sup>30</sup>) was not used in this series. Somatotyping requires considerable specialized training, but it would enable more accurate description of body type.

By using the build index, i.e., chest circumference/height as described by Robinson,<sup>27</sup> 3 patients were found to be of linear

30 per cent of all cancer in women.<sup>5</sup> Marble believes that cancer does not predispose to diabetes and diabetes does not predispose to cancer, but that both diseases occur more frequently in the aged. The number of carcinomas of the endometrium present in his series, however, was undoubtedly small.

Glucose tolerance tests were done on all our patients (1.75 gm/kilo. glucose given orally, and venous blood samples were drawn after  $\frac{1}{2}$ , 1, 2, 3, and 4 hour intervals). Five patients showed relatively severe dia-

composite graph of the glucose tolerance for the entire group.

In view of the work of Joslin<sup>18</sup> in classifying diabetes according to obesity, it is not surprising to find a number of diabetics in a group of obese women. As shown here, the incidence of diabetes in endometrial carcinoma is high. Whether this is the percentage of diabetes found in women with normal endometria, of the same age, build, and weight is doubtful. Kisch<sup>19</sup> reports that 15 per cent of the women aged fifty-five

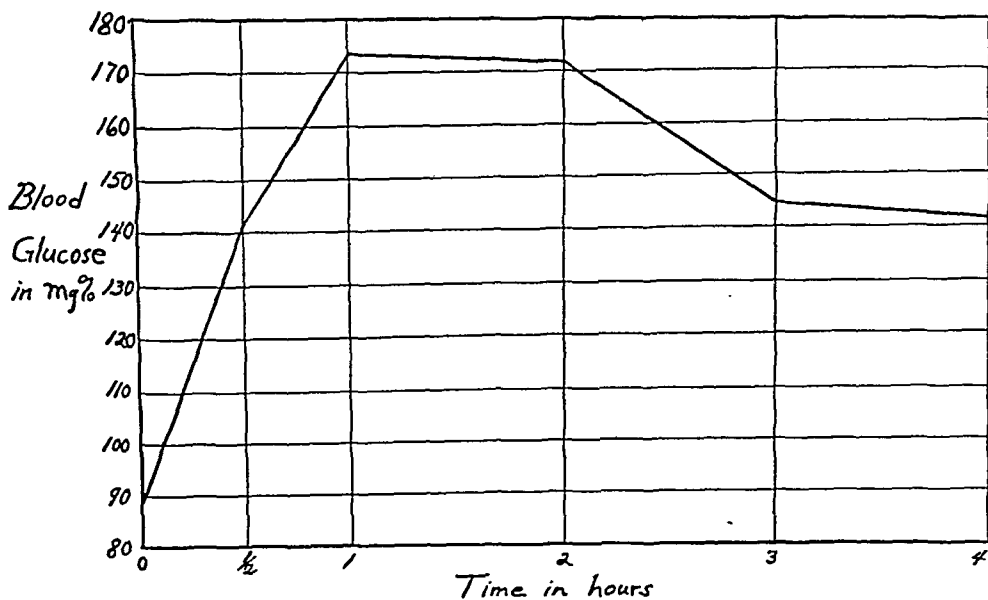


FIG. 2. Composite graph of glucose tolerance tests.

betes with the maximum rise of the glucose tolerance curve going above 250 mg. per 100 cc., and in 4 of these cases, it remained above 150 mg. per 100 cc. for four hours. There was moderate alteration of the curve with an elevation above 180 mg. per 100 cc. (usually considerably higher) and a blood sugar level after four hours above 140 mg. per 100 cc. in 4 cases. Six patients had a mild diabetes with a maximum rise slightly above 180 mg. per 100 cc. and/or with a three hour blood sugar level above 120 mg. per 100 cc. Five showed a rise in blood sugar levels to between 170 mg. per 100 cc. and 180 mg. per 100 cc. with three hour levels between 100 and 120 mg. per 100 cc. The remaining 3 had levels falling below the last group. Four patients gave a family history of diabetes. Figure 2 shows the

with "alimentary corpulence develop diabetes and 50 per cent of those with pronounced constitutional obesity develop it." In our series, the average age was sixty-one and, by the method of Robinson,<sup>27</sup> 16 were heavyweights. Yet, of these 16, 13 showed abnormal glucose tolerance curves (maximum blood sugar level above 180 mg. per 100 cc. with maintained elevated level after three hours above 120 mg. and 8 showed moderate or severe diabetes. John<sup>16</sup> reported that 65.8 per cent of 172 obese males and females (ages not stated) showed abnormal glucose tolerance curves. Ogilvie<sup>25</sup> found that abnormal glucose tolerance was related to the duration of obesity and thus explained the fact that all obese persons are not diabetic. Of the 15 showing abnormal glucose tolerance curves, 13 pre-

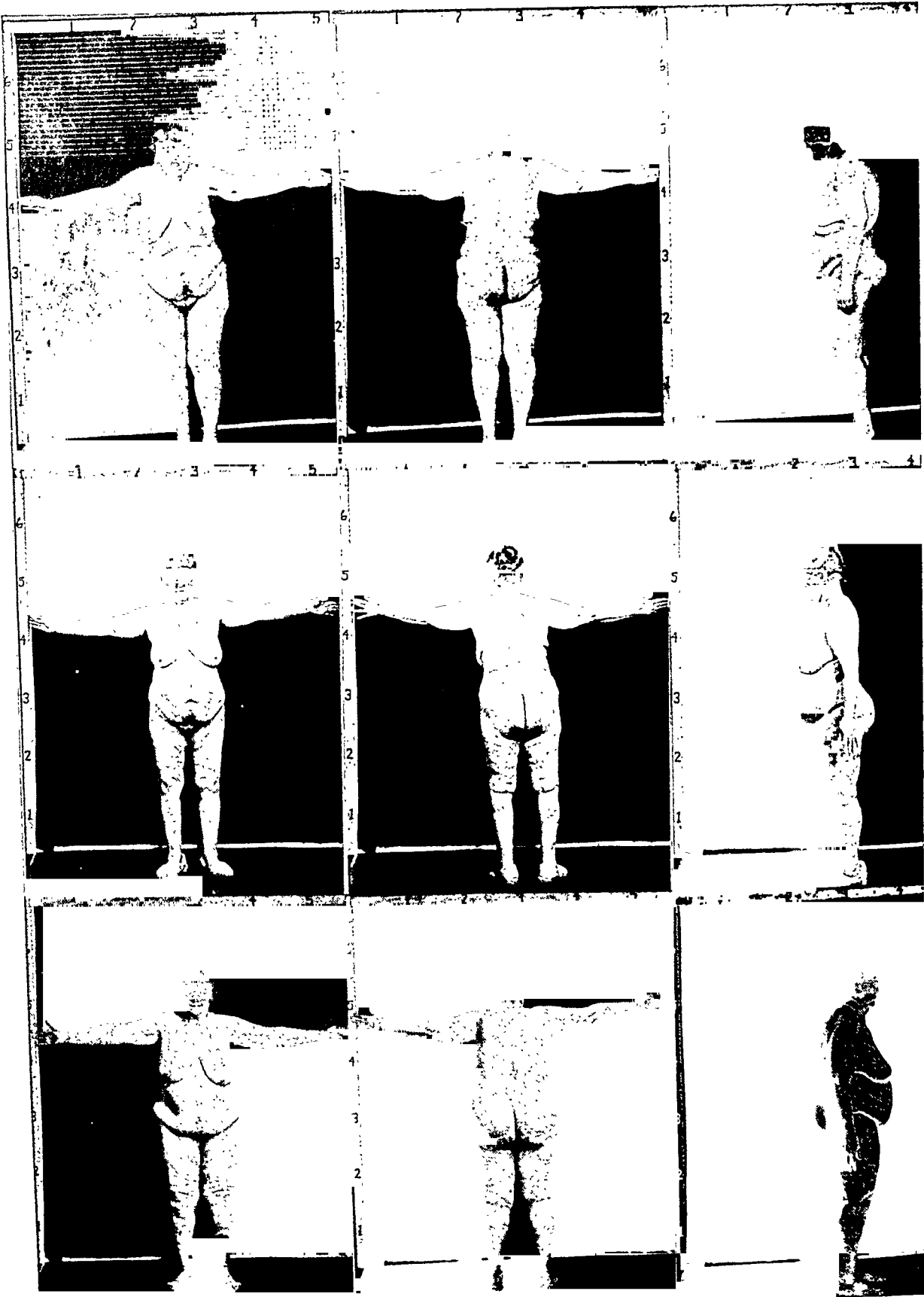


FIG. 3. Typical body build of individuals with carcinoma of the endometrium.

sented heavyweight characteristics, and of these 13, all but one had been at least 10 per cent above the average normal weight for their age and height during the preceding twenty years. Regardless of the incidence of obesity in this series, the number of diabetics present cannot be accounted for.

*Hypertension.* Hypertension, just as obesity and diabetes, has been noted only as a factor of inoperability in the various series of carcinoma of the endometrium. No specific figures of incidence, however, have been presented. Of our 23 cases, 18 had abnormally high blood pressures (systolic pressure above 140 and/or diastolic above 90). Twelve of these 18 had lateral body builds and 3 more had lateral intermediate builds. The average blood pressure of the entire group was 164/87.

Although it has long been thought that obesity was an important factor in the production of hypertension, the extensive work of Robinson<sup>27</sup> on this subject emphasizes the fact that *body build* is usually the most important influencing factor. They have shown that when the weight is carefully held constant, both mean systolic and mean diastolic pressures significantly increase as the body type broadens out into the lateral or broad build. The broad-chested individuals in the lateral build group have a higher average blood pressure, a greater incidence of hypertension, and a lower incidence of low blood pressure than do the linear or slender builds. He concludes that hypertension is a part of the broad-chested person's endowment; and, although obesity too is a part of the same pattern, it is not the influencing factor in hypertension. The large percentage of lateral build individuals in carcinoma of the endometrium undoubtedly accounts for the frequency of hypertension, if one accepts the work of Robinson.

The basal metabolic rate in our group varied from +62 to -11 per cent, the average being +9 per cent. Seven patients had abnormally high rates and one was abnormally low, but no definite correlation

between these and the previously described factors could be detected.

Blood cholesterols were performed on all patients by using the Bloor method,<sup>2</sup> in which the upper limit of normal values was 200 mg. per 100 cc. An average value of 286 mg., a maximum value of 377 mg., and a minimum value of 173 mg. were obtained. No correlation was found between these values and the presence of obesity, diabetes, or hypertension except that 3 out of 4 patients with values below 250 mg. per 100 cc. were not obese and showed only slight abnormalities in their glucose tolerance curves.

#### SUMMARY

Obesity, a heavy lateral body build, hypertension, and diabetes are found rather frequently in patients with carcinoma of the endometrium. Obesity is known to be an important etiologic factor in diabetes. The tendency to be overweight frequently accompanies the type of body build in which hypertension and carcinoma of the endometrium are most often found. Body build seems to be the most important single factor. It is not to be implied that the lateral body build produces cancer of the endometrium, but that perhaps the same factor or factors produce or permit both states in the same individual. It follows that postmenopausal bleeding in the obese, hypertensive woman who has a diabetic tendency should be studied more carefully than in the thin lateral build individual, inasmuch as carcinoma of the endometrium is found more frequently in the former type.

I wish to thank Dr. Juan A. del Regato who pointed out the frequency of diabetes, obesity, and hypertension in his patients with carcinoma of the endometrium. This observation originated this study.

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# ROENTGEN TUBE POTENTIALS IN DIAGNOSTIC ROENTGENOLOGY

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IN RECENT months the Tuberculosis Control Division of the United States Public Health Service has been conferring with representatives of the roentgen-ray industry to promote standardization in the basic design of roentgenographic equipment used in tuberculosis case-finding.<sup>1</sup> Among several subjects under discussion has been one concerning the standardization of the terminals of high voltage cables. As is well known, each manufacturer of roentgen equipment, at present uses a cable termination which differs in one or more ways from those of other manufacturers. This situation has frequently been the cause of serious difficulty and inconvenience in servicing and maintaining the roentgen equipment of the Tuberculosis Control Division. It has been often responsible for similar trouble in the Army and Navy and in other agencies operating large quantities of roentgen apparatus. The multiplicity of cable designs has also been of some concern to the individual roentgenologist for it has greatly limited his freedom in selecting the equipment which will optimally meet his requirements and has increased unnecessarily the cost of that equipment.

The roentgen-ray industry appears to be sympathetic toward a program whereby standardization of cable terminal design may be achieved. It has, however, expressed a reluctance to adopt a particular design until the voltage range that will be required in diagnostic roentgenology during the next several years is clarified. Recently there have been several indications that voltages in excess of 100 kv. (peak) are desirable in this field. It has been shown, for example, that in fluoroscopy, the roentgen dosage received by a patient decreases significantly as the kilovoltage is increased when a particular screen brightness level is maintained. It is also known

that efficiency of roentgen-ray production in a roentgen tube improves when the kilovoltage is increased. Advantage of this fact might well be taken in mass roentgenography of the chest where one frequently operates close to the capacity of the roentgen machine. Furthermore there are several investigators who have been experimenting with high voltage techniques in general roentgenography and who believe there is an advantage in using these techniques in some types of examination.

If the trend is toward the use of higher voltages in diagnostic roentgenology, such a trend obviously should be taken into consideration by the roentgen-ray industry before it adopts a particular high voltage cable terminal design. Otherwise many of the advantages of the standardization would be lost by the design becoming obsolete within a few years.

If an effort to determine as closely as possible the kilovoltage range which will be required in diagnostic roentgenology within the foreseeable future, the Radiology Section of the Tuberculosis Control Division has undertaken a quantitative investigation of the several phases of the problem. From the results of this study, the roentgen-ray industry has tentatively agreed to proceed with a program of cable terminal standardization:

The investigation undertaken by this laboratory has involved the study of three problems; (a) the effect of kilovoltage on the quality of roentgenographic and roentgenoscopic images; (b) the effect of kilovoltage on the efficiency of roentgen-ray production, and (c) the effect of kilovoltage on the roentgen dosage received by a patient during roentgenoscopy

(a) *Effect of Kilovoltage on Quality of Roentgenographic and Roentgenoscopic Images.* It is well known that the interpreta-



bility of a roentgenographic or roentgenoscopic image is dependent, in part, on the contrast which the image exhibits. In general, high contrast levels are consistent with excellent interpretability and low contrast levels with poor interpretability.

It has recently been shown<sup>2</sup> that the contrast of a roentgenographic or roentgenoscopic image is a function of the mass absorption coefficient and density of the image-producing structure, of the mass absorption coefficient and density of the surrounding tissues, of the ratio of the primary to total radiation received by the film or screen and, in the case of a roentgenographic image, of the inherent contrast factor of the film. These several factors are related quantitatively by the equation

$$C = (b_b \rho_b - b_i \rho_i) (G_p / G_t) g x \quad (1)$$

where

$C$  is the contrast of the image appearing in the roentgenographic film or roentgenoscopic screen,

$b_i$  and  $b_b$  are the mass absorption coefficients (expressed in terms of decadic logarithms) of the image-producing structure and of the surrounding tissues respectively,

$\rho_i$  and  $\rho_b$  are the densities of the image-producing structure and of the surrounding tissues respectively,

$G_p$  is the intensity of the primary radiation impinging in the film or screen,

$G_t$  is the intensity of the total radiation (primary plus secondary radiation) impinging on the film or screen,

$g$  is the inherent contrast factor of the roentgenographic film (this factor has a value of unity for roentgenoscopic images) and

$x$  is the thickness of the image-producing structure.

The kilovoltage applied to the roentgen tube exerts a controlling influence over the values of  $b_i$ ,  $b_b$ , and  $G_p/G_t$  and thereby affects the diagnostic quality of roentgenographic and roentgenoscopic images.

To determine the exact relationship between kilovoltage and image quality it is

necessary, therefore, to obtain quantitative data on these several parameters for the tissues usually encountered in medical roentgenology through the kilovoltage range in which one is interested and apply those data in equation (1).

The types of tissue encountered in medical roentgenography fall into two general categories. There are those usually referred to as soft tissue and comprise skeletal muscle, connective tissue, fat, and so forth. These tissues are mainly composed of hydrogen, oxygen, nitrogen and carbon and have mass absorption coefficients closely similar to one another and almost identical to Masonite presdwood.<sup>2</sup> The second category includes those tissues which are largely composed of inorganic calcium salts. The mass absorption coefficients of these materials are closely identical to that of calcium apatite— $(\text{Ca}_{10} \text{CO}_3 (\text{PO}_4)_6)$ .

The mass absorption coefficients (decadic) of Masonite presdwood and of calcium apatite have been recently published by the author<sup>2</sup> for the kilovoltage range of 30 to 85 kv. (peak). During the present investigation the range was extended to 200 kv. (peak). They are plotted graphically as a function of peak kilovoltage in Figure 1. Curve  $A$  indicates the mass absorption coefficient (decadic) of calcium apatite when the filtration in the roentgen beam is 5.0 cm. of Masonite presdwood (density = 1.07) and 2.0 cm. of calcium apatite (density = 1.0). The presdwood was included when these measurements were made to simulate surrounding soft tissue normally present about calcified structures; the additional calcium apatite filtration was used because normally the thickness of a calcified structure is of the order of 2.0 cm. or greater. Curve  $B$  indicates the values of the mass absorption coefficient (decadic) of calcium apatite when the filtration in the roentgen beam is 20 cm. of Masonite presdwood and 2.0 cm. of calcium apatite. Curves  $C$  and  $D$  indicate respectively the mass absorption coefficients (decadic) of Masonite presdwood when the roentgen beam filtration

includes 5.0 and 20 cm. of Masonite presdwood.

It is evident that the mass absorption coefficient of calcium apatite decreases rapidly with increasing kilovoltage whereas that of Masonite presdwood is only slightly affected by roentgen tube potentials. It therefore follows that if one is primarily interested only in osseous structures the lowest kilovoltage consistent with a reasonable exposure time will produce optimum contrast and interpretability. On the other hand, if one is primarily interested only in soft tissues it makes little difference what roentgen tube potential is used within the range of 30 to 200 kv. (peak) since experience has shown that changes in contrast of approximately 25 per cent must occur before the difference may be appreciated.

In actual practice, however, the situation seldom occurs when one is interested either in osseous structures alone or in soft tissues alone. Usually both types of tissue are under diagnostic investigation. For example, in a film exhibiting a bone sarcoma one is interested not only in the osseous involvement but also in the soft tissue invasion. The curves illustrated in Figure 1 do not give sufficient data from which to evaluate optimal roentgen kilovoltage conditions for circumstances of this sort. From Figure 1 one might suspect that the lowest possible kilovoltage consistent with adequate penetration of the structure would produce the most satisfactory results since bone contrast will be greatest under this condition and soft tissue contrast will also be at its highest level. However, when one is trying to visualize two different types of tissue another factor is involved which invalidates this reasoning.

Under most circumstances, the conditions which promote high bone contrast also produce large density differences between the images of the bone and of the soft tissue appearing on a roentgenographic film. Accordingly when a film is exposed so that the bone image falls within the useful range of film blackening, the images of the soft tissues will be so dense as to preclude

interpretation. On the other hand, if the film is optimally exposed for the soft tissues, the bone image will be so light in density that little can be discerned in it. This large density difference is largely caused by the marked absorption which the

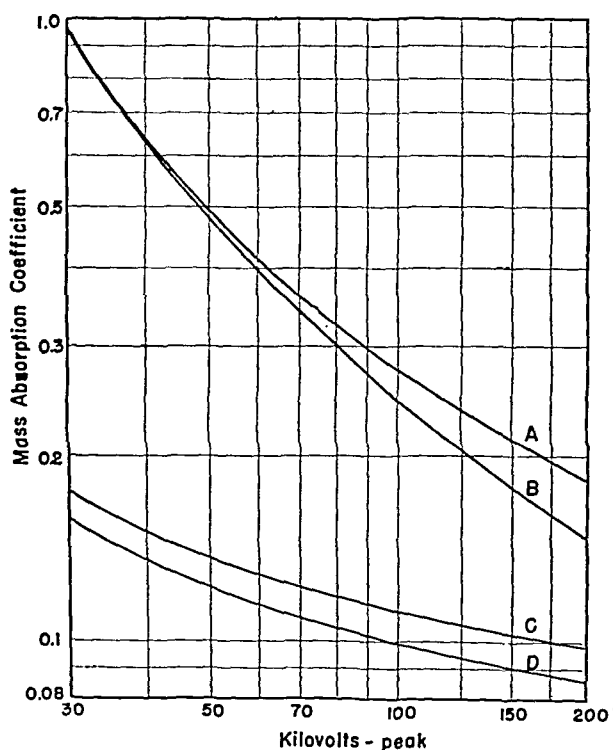


FIG. 1. Mass absorption coefficients (expressed in terms of decadic logarithms) of calcium apatite and of Masonite presdwood plotted as a function of the voltage applied to the roentgen tube. Curve A, mass absorption coefficient of calcium apatite when filtration in roentgen beam is 5.0 cm. of Masonite presdwood (density = 1.07) and 2.0 cm. of calcium apatite (density = 1.00); Curve B, mass absorption coefficient of calcium apatite when the filtration in the roentgen beam is 20 cm. of Masonite presdwood and 2.0 cm. of calcium apatite; Curve C, mass absorption coefficient of Masonite presdwood when the roentgen beam filtration is 5.0 cm. of Masonite presdwood; Curve D, mass absorption coefficient of Masonite presdwood when the roentgen beam filtration is 20 cm. of Masonite presdwood.

roentgen beam undergoes when passing through the initial calcified layers of bone. The extent of this absorption is shown graphically in Curves A, B and C of Figure 2 where the mass absorption coefficients (decadic) of thin layers of calcium apatite, approaching a thickness of 0.0 cm., are

plotted as a function of roentgen tube kilovoltage when the filtration in the roentgen beam is respectively 2.5, 5.0 and 10 cm. of Masonite presdwood. Curve *E* indicates the values of the mass absorption coefficient (decadic) of calcium apatite for the same

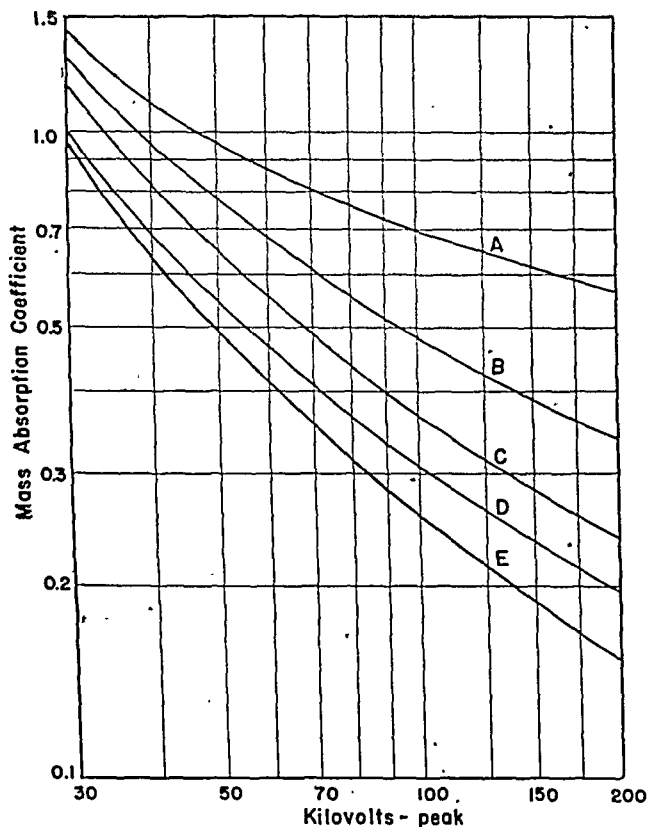


FIG. 2. Mass absorption coefficients (expressed in terms of decadic logarithms) of thin layers of calcium apatite (approaching zero thickness) plotted as a function of the voltage applied to the roentgen tube. Curve *A*, roentgen beam filtration 2.5 cm. of Masonite presdwood; Curve *B*, roentgen beam filtration 5.0 cm. of Masonite presdwood; Curve *C*, roentgen beam filtration 10 cm. of Masonite presdwood; Curve *D*, roentgen beam filtration 5.0 mm. of aluminum; Curve *E*, roentgen beam filtration 2.0 cm. of calcium apatite (density equal 1.0).

conditions as those listed for Curve *B* in Figure 1.

It is evident that there is a reduction in the absorption of the initial calcified layers of osseous tissue as one increases kilovoltage. Therefore the large density differences between the images of bone and soft tissue appearing in the roentgenogram will tend to be minimized when the kilovoltage is increased. However, this increase in kilo-

voltage also decreases the values of the mass absorption coefficient of the deeper layers of the calcified tissues (Curve *E*, Fig. 2) and thereby causes a considerable diminution in osseous contrast and detail. It is therefore desirable not to increase roentgen potentials unduly.

In the foregoing connection it is interesting to observe that the absorption in the initial calcified layers is substantially decreased by the presence of presdwood in the beam (Curves *B* and *C*, Fig. 2). Accordingly one may expect that the density differences between bone and soft tissue images will usually be small when heavy parts (abdomen) are roentgenographed and large when thin parts (hand) are examined. This is actually what is observed in practice. Advantage may be deliberately taken of this fact by introducing additional filtration in the roentgen beam particularly when small structures are under examination. When 5.0 mm. of aluminum are added, the values of the mass absorption coefficient (decadic) of the initial layers of calcium apatite approach those shown in Curve *D*, Figure 2. The locus of this curve remains essentially stationary regardless of the thickness of any presdwood filtration that is present. Furthermore the locus of Curve *E* is essentially unaffected by the presence of either aluminum or presdwood filtration. Therefore the presence of aluminum filtration greatly diminishes the absorption of the initial calcified layers without materially changing the absorption coefficient of the deeper layers. Accordingly the density differences between bone and soft tissue images are reduced to a minimum without impairment of bone detail. It seems desirable as a general rule then to add aluminum filtration to the roentgen beam, when one is interested in the images of both osseous and soft tissues, regardless of the kilovoltage applied to the roentgen tube. As for the optimum kilovoltage in a particular case, it seems clear that the lowest voltage consistent with the production of the image-densities of both the osseous and soft tissues within the useful range of film blackening

ing will be most desirable. Under this condition both bone and soft tissue detail will approach a maximum. In actual practice such voltages will range usually between 50 and 90 kv. (peak) if a filter is used, the proper value depending on the thickness of the osseous structure under examination but in no case being extremely critical due to the large changes in contrast which must occur before significant differences in diagnostic quality are observed.

It has frequently been argued that more satisfactory results might be achieved in chest roentgenography by employing roentgen tube potentials in excess of 100 kv. (peak) for under these conditions the ribs and clavicles are more adequately penetrated and thereby do not obscure the underlying pulmonary tissues. That this is true is well demonstrated in Figure 2 where the absorption of the initial layers of the calcified material within the ribs under normal chest roentgenography are essentially illustrated in Curve C; that is, the 10 cm. of presdwood filtration used in the preparation of this curve is approximately equivalent to the absorption of a 20 cm. chest.<sup>3</sup> However, one objection to this procedure should be pointed out. Although it is true that the reduced absorption of the ribs at high voltages reduces the shadow they cast on the film or screen, it is similarly true that pathological calcification within the chest also becomes more difficult to perceive and differentiate from non-calcified infiltrations; indeed, calcified lesions begin to approach non-calcified lesions in appearance. It therefore is important, when one employs relatively high kilovoltages (i.e. in excess of 100 kv. (peak)) in chest roentgenography, that one repeat the examination at a lower kilovoltage, when pathology is found, to determine whether or not calcification is present.

In the discussion thus far nothing has been said regarding the effect of kilovoltage on the ratio of primary to total radiation received by a roentgenographic film or roentgenoscopic screen during exposure. As indicated in equation (1) this must be an

important consideration when the effect of kilovoltage on the quality of roentgen images is appraised.

The ratio of primary to total radiation under a wide variety of roentgen conditions has heretofore been determined within the

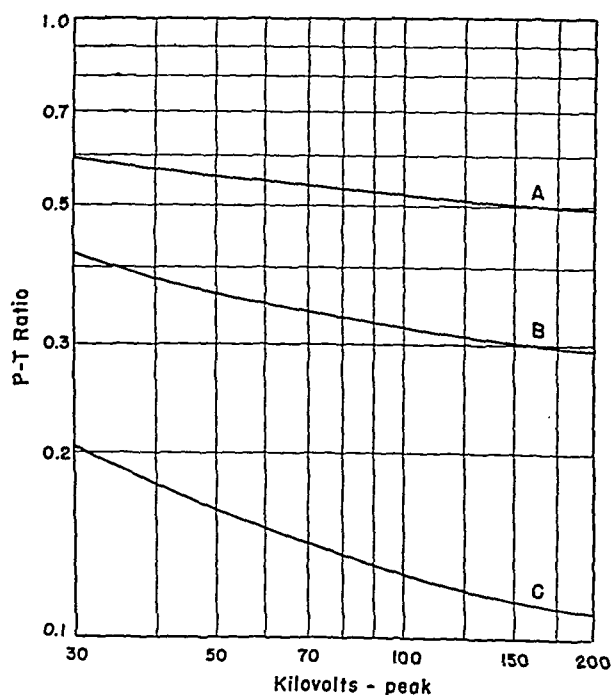


FIG. 3. Ratio of primary to total radiation received by roentgenographic film or roentgenoscopic screen plotted as a function of the voltage applied to the roentgen tube. Curve A, roentgen beam projected through thickness of presdwood 5.0 cm. in thickness; Curve B, roentgen beam projected through presdwood phantom 10 cm. in thickness; Curve C, roentgen beam projected through presdwood phantom 20 cm. in thickness. Portal area irradiated in each case is 900 sq. cm.

kilovoltage range of 30 to 85 kv. (peak) by the author.<sup>2</sup> The range has recently been extended to 200 kv. (peak) and the resulting data summarized in Figures 3 and 4. In Figure 3, the ratio of primary to total radiation is plotted as a function of kilovoltage when the portal area under irradiation is 900 sq. cm. Curve A indicates the ratio when a phantom of presdwood (density=1.07), 5.0 cm. in thickness, is used.

Curves B and C apply to phantoms 10 and 20 cm. in thickness respectively. It will

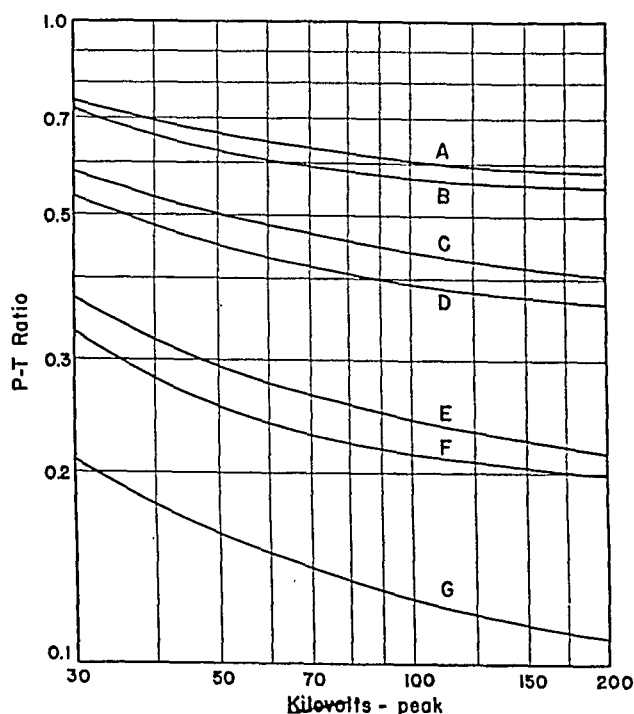


FIG. 4. Ratio of primary to total radiation received by roentgenographic film or roentgenoscopic screen plotted as a function of the voltage applied to the roentgen tube when the roentgen beam is projected through a presdwood phantom 20 cm. in thickness. Curve *A*, portal area irradiated—300 sq. cm., roentgen beam filtration—inherent tube filtration only, scattered radiation reduced by grid having efficiency of 80 per cent; Curve *B*, portal area irradiated—300 sq. cm., roentgen beam filtration—5.0 mm. Al, scattered radiation reduced by grid having an efficiency of 80 per cent; Curve *C*, portal area irradiated—900 sq. cm., roentgen beam filtration—inherent tube filtration only, scattered radiation reduced by grid having efficiency of 80 per cent; Curve *D*, portal area irradiated—900 sq. cm., roentgen beam filtration—inherent tube filtration only, scattered radiation reduced by grid having efficiency of 80 per cent; Curve *E*, portal area irradiated—300 sq. cm., roentgen beam filtration—5.0 mm. Al, scattered radiation reduced by grid having efficiency of 80 per cent; Curve *F*, portal area irradiated—300 sq. cm., roentgen beam filtration—5.0 mm. Al; Curve *G*, portal area irradiated—900 sq. cm., roentgen beam filtration—inherent tube filtration only.

be observed that kilovoltage has very little effect on the ratio when the thickness of presdwood is 5 or 10 cm. and only becomes appreciable at thicknesses of 20 cm. and over. However, roentgenography and roentgenoscopy are seldom done on anatomical structures 20 cm. in thickness without

either reducing the portal area being irradiated or using a grid. In Figure 4 the ratio of primary to total radiation is plotted as a function of kilovoltage for a presdwood phantom 20 cm. in thickness when *A*, the portal area is 300 sq. cm. and a grid whose efficiency is 80 per cent is used; *B*, when the portal area is 300 sq. cm., an 80 per cent efficient grid is used, and 5.0 mm. of aluminum filtration is present in the roentgen beam; *C*, when the portal area is 900 sq. cm. and an 80 per cent efficient grid is used; *D*, when the portal area is 900 sq. cm., an 80 per cent efficient grid is used and 5.0 mm. Al filtration is present; *E*, when the portal area is 300 sq. cm. and no grid is used; *F*, when the portal area is 300 sq. cm., no grid is used and 5.0 mm. Al filtration is present, and *G*, when the portal area is 900 sq. cm. and no grid is used. Almost all roentgen conditions are covered by either Curves *A* and *B* of Figure 3 or Curves *A*, *B*, *C*, and *D* of Figure 4 and that under these conditions the effect of kilovoltage on the ratio is extremely small. These data are supported by measurements made some time ago by Wilsey.<sup>4</sup>

Summarizing the data concerning the effect of the kilovoltage applied to a roentgen tube on the quality of roentgenographic and roentgenoscopic images, the following may be reasonably said:

(a) Kilovoltage has a relatively large influence on the detail with which osseous structures are recorded and the lowest kilovoltage consistent with a reasonable exposure time is usually optimum when one is interested in bone detail alone.

(b) Kilovoltage has a relatively minor effect on soft tissue detail within the ranges used in medical roentgenography and almost any kilovoltage will produce satisfactory results when one is interested in soft tissue detail alone.

(c) When one is interested in both soft tissue and bone detail, the lowest kilovoltage consistent with the placement of the image densities of both tissues within the useful range of film blackening will usually be optimum. This kilovoltage may approach rather high levels but in most

cases may be brought within the range of 50 to 90 kv. (peak) by the use of aluminum filtration.

(d) In chest roentgenography, kilovoltages in excess of 100 kv. (peak) have the great advantage of permitting one to see the pulmonary structures behind the ribs. It is frequently wise to use a grid routinely when such kilovoltages are employed not only to remove the somewhat increased amount of scattered radiation that is present but also to increase the contrast. This improves the clarity of the pulmonary images materially and since the useful range of film blackening of a roentgenogram is less completely filled when the ribs and clavicles absorb but little radiation, the grid may be employed without the likelihood of any of the significant thoracic images falling beyond the useful range of film blackening. Recheck examinations should be made at lower voltages to facilitate the differentiation of calcified and non-calcified pathology.

From the foregoing it is clear that the need for higher kilovoltages than those now generally provided in medical roentgenographic equipment (i.e. higher than 100 kv. (peak)) exists only in chest roentgenography. Even this need cannot be considered great for almost the same advantages may be obtained by the use of aluminum filtration as by the adoption of higher voltages. This may be well illustrated by Curve C, Figure 2 which indicates the absorption of the ribs under normal roentgenographic conditions and Curve D, Figure 2 which indicates this absorption when 5.0 mm. of aluminum are present. The absorption under the latter condition at 100 kv. (peak) is not significantly different than that at 150 kv. (peak) in the former.

(b) *Effect of Kilovoltage on the Efficiency of Roentgen-Ray Production.* In general roentgenography, the efficiency of roentgen-ray production is of no great concern within the range of kilovoltages available in present day equipment. Roentgenography of even the heaviest anatomical structures may usually be performed with-

out approaching the heat liberating capacity of the roentgen tube. In mass roentgenography of the chest and in spot-filming roentgenoscopy, however, the situation is quite different. Here the heat liberating capacity of the roentgen tube is frequently reached or exceeded even under normal operating schedules due to the large quantities of radiation employed in these procedures.

It is well known that the efficiency of a roentgen tube improves when the applied kilovoltage is increased; that is, the intensity of the roentgen radiation generated per watt of electrical power consumed by the tube becomes appreciably greater when the kilovoltage is increased. Accordingly since a particular quantity of radiation is required to produce a given roentgenographic effect, that effect may be produced with less energy applied to the tube, and therefore with the development of less heat, at high kilovoltages than at low. Thus, the use of high kilovoltages in mass roentgenography of the chest and in spot-filming roentgenoscopy should be advantageous.

The quantitative manner in which roentgen tube efficiency varies with kilovoltage depends on the way in which roentgen efficiency is defined. As applied to problems in mass roentgenography of the chest the term may be defined most satisfactorily as the luminous intensity (brightness) of the photofluorographic screen produced per watt of electrical power consumed by the roentgen tube under average roentgenographic conditions; that is,

$$E = B/P \quad (2)$$

where E is roentgen tube efficiency

B is the luminous intensity or brightness of the screen and

P is the power consumed by the roentgen tube.

Since it is the luminous intensity which directly controls the density of the photofluorogram such a definition has the advantage that it indicates efficiency in terms that are directly applicable to the solution of problems concerning the heat generated

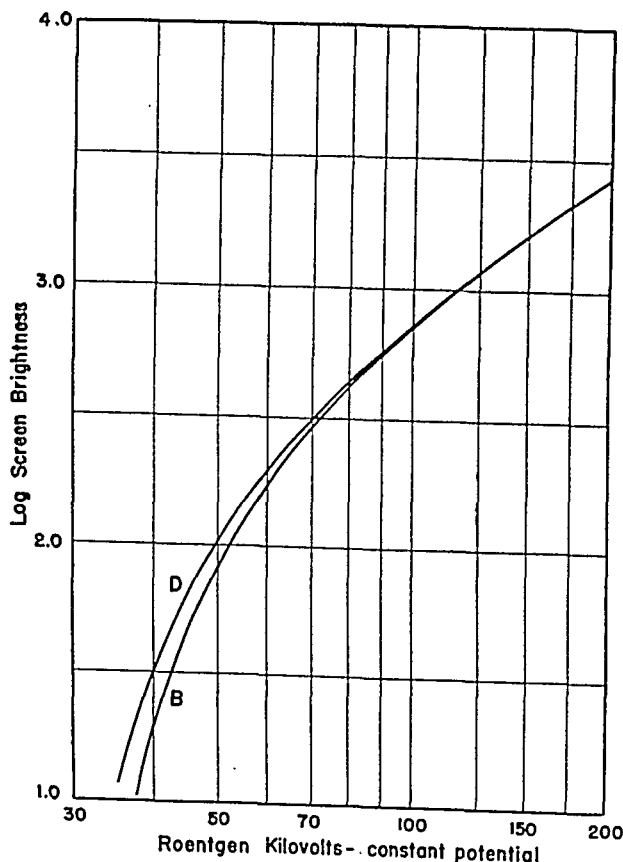


FIG. 5. Log screen brightness levels of Patterson Type "B" and Type "D" fluorescent screens plotted as a function of roentgen tube voltage (constant potential). Measurements were made through presdwood phantom 10 cm. in thickness and a grid, having an efficiency of 80 per cent, was interposed between the phantom and the fluorescent screens.

in a roentgen tube under various exposure schedules.

To determine the efficiency of roentgen-ray production from equation (2) it is necessary to measure the brightness of a photofluorographic screen with different kilovoltages applied to the roentgen tube and divide each value by the corresponding power consumed by the tube. Such measurements must of course be made under average photofluorographic conditions and with a constant tube-screen distance. Chamberlain,<sup>3</sup> as previously pointed out, has indicated that the average chest has an equivalent roentgen-ray absorption of approximately 10 cm. of Masonite presdwood. Since a wafer grid is customarily employed in photofluorography, average photofluorographic conditions then are satisfied if the

measurements of screen brightness are made through a 10 cm. presdwood phantom and a wafer grid.

Measurements of screen brightness, using Patterson Type "B" and Type "D" screens, were made during this investigation through a kilovoltage range of 30 to 200 kv. (peak) when a presdwood phantom, 10 cm. in thickness, and a grid were placed in the roentgen beam; the phantom area normal to the beam was 900 sq. cm. Screen brightness levels were determined with a photoelectric intensitometer placed in fixed relation to the screens. Since the spectral distribution of the light emitted by a fluorescent screen is constant regardless of the quality of the exciting roentgen radiation, the intensitometric readings so ob-

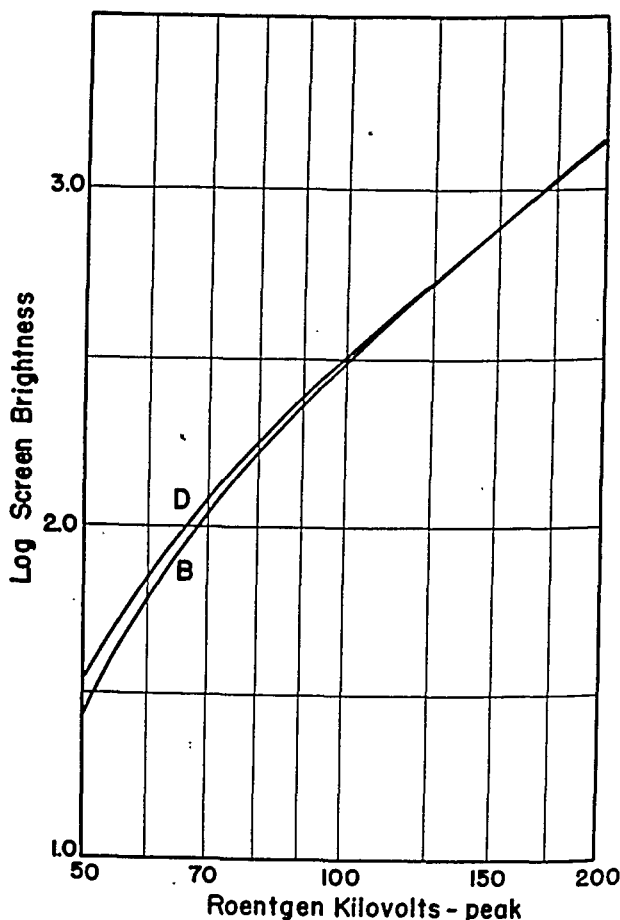


FIG. 6. Log screen brightness levels of Patterson Type "B" and Type "D" fluorescent screens plotted as a function of the peak roentgen tube voltage (sinusoidal wave form). These curves were calculated from the data provided in Figure 5.

tained are proportional to the photographic flux density received by a film during photofluorography; that is, the intensitometric readings constitute a reliable measure of screen brightness as seen from the standpoint of a photofluorographic film.

The roentgen generator with which the screens were excited was a constant potential type operating at a fixed tube current. Previous studies had indicated that the wave-form of conventional pulsating generators varied widely through the kilovoltage range under investigation and accordingly the power consumed by the roentgen tube was difficult to calculate for the various kilovoltage levels. By using a constant potential generator it was possible to calculate by graphical analysis the brightness of the photofluorographic screen when the wave-form of the roentgen tube potential is a pure sine wave. It then became possible by means of equation (2) to evaluate roentgen tube efficiency, under conditions approaching those normally encountered in actual practice, with reasonable accuracy.

In Figure 5 are plotted the log screen brightness levels of both the Type "B" and type "D" screens through the voltage range of 30 to 200 kv. (constant potential). From those data the average brightness levels when the roentgen voltage is sinusoidal were determined and are plotted as a function of peak roentgen kilovoltage in Figure 6.

From Figure 6 and equation (2) the relative efficiency of roentgen-ray production was calculated and is shown plotted as a function of peak kilovoltage in Figure 7. It is evident that roentgen efficiency improves very considerably as the kilovoltage is raised. Indeed at 150 kv. (peak) the efficiency is more than 50 per cent greater than at 100 kv. (peak). In passing it should be pointed out that although the curves for the Type "D" screen lie somewhat above those of the Type "B" screen in Figures 5, 6, and 7, this does not necessarily mean that the former is the better. It only means that as far as the phototube in the photoelectric

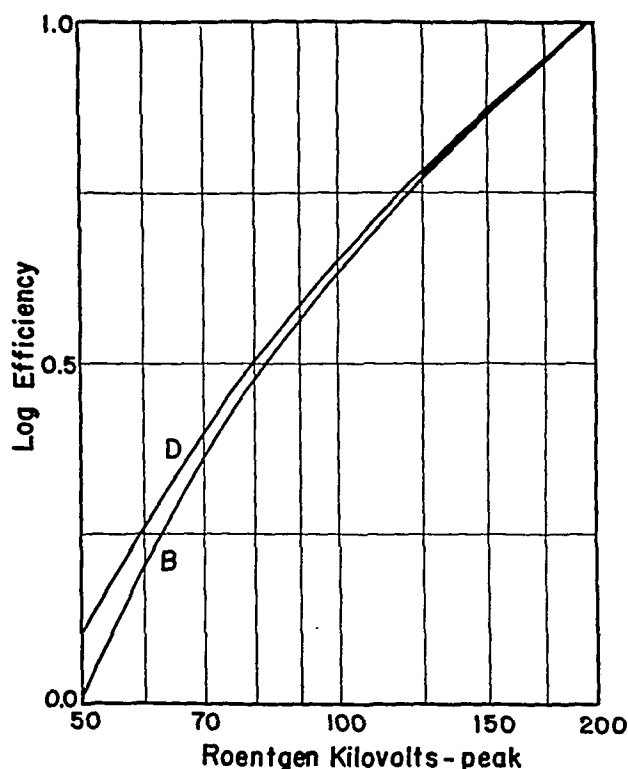


FIG. 7. Relative efficiency of roentgen-ray production under average photofluorographic conditions when Patterson Type "B" and Type "D" fluorescent screens are used. Values are plotted as a function of the peak voltage applied to the roentgen tube. These data were determined from values derived from Figure 6 and substituted in equation (2).

intensitometer is concerned, the Type "D" screen produces a greater current output in the phototube than the Type "B" screen. Photographically, the positions of the curves might be reversed, on the one hand, or even more widely separated, on the other, depending on the relative speeds of the films used with the two screens. Regardless of this, however, the argument that an increase in kilovoltage produces a very real improvement in roentgen tube efficiency is still valid. Whether or not the gain in efficiency is great enough to warrant the increased cost of producing equipment able to withstand the higher voltages, only the roentgen-ray industry will be able to say. The gain does appear to be sufficient to require very careful consideration of the problem especially when it has been shown in section (a) of this paper that high kilovoltages in routine chest roentgenography



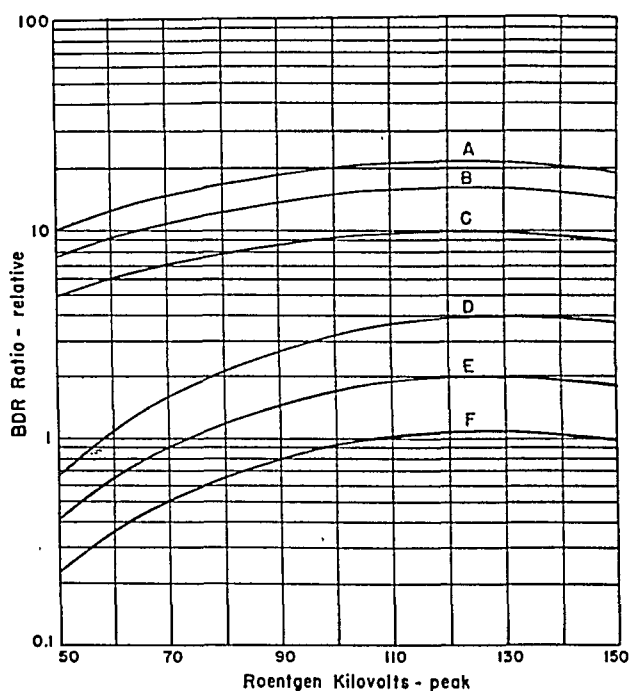


FIG. 8. Ratio of relative roentgenographic screen brightness to dosage rate produced by roentgen beam projected through phantom of Masonite presdwood. Measurements were made with photo-electric intensitometer scanning a Patterson Type "B" roentgenoscopic screen and with a Victoreen dosimeter determining the roentgen dosage (including backscatter). The tube-screen distance was maintained constant at 27 inches. Curve A, portal area irradiated—300 sq. cm., thickness of phantom—10 cm., Curve B, portal irradiated—900 sq. cm., thickness of phantom—10 cm., Curve C, portal irradiated—900 sq. cm., thickness of phantom—10 cm., scattered radiation impinging upon roentgenoscopic screen reduced by grid having an efficiency of 80 per cent; Curve D, portal irradiated—300 sq. cm., thickness of phantom—20 cm., Curve E, portal irradiated—900 sq. cm., thickness of phantom—20 cm., Curve F, portal irradiated—900 sq. cm., thickness of phantom—20 cm., scattered radiation impinging upon roentgenoscopic screen reduced by grid having efficiency of 80 per cent.

may be expected to produce diagnostically superior roentgenograms.

(c) *Effect of Kilovoltage on Roentgen Dosage Received by Patient during Roentgenoscopy.* In the preceding section of this paper it has been shown that the brightness of a fluorescent screen increases markedly when the kilovoltage applied to the roentgen tube is increased. It is also true that in roentgenoscopy the roentgen dosage rate received by the patient increases rapidly

with kilovoltage. If, however, the increase in screen brightness is greater than that of roentgen dosage rate, the ratio of the brightness of the screen to the dosage rate imposed on the patient will increase with kilovoltage and accordingly when a given screen brightness level is maintained the actual dosage received by a patient during a roentgenoscopic examination will be less when high kilovoltages are applied to the roentgen tube than when the voltage is lower. The opposite effect will of course occur if the increase in screen brightness is less than that of the dosage rate.

What actually happens under average roentgenoscopic conditions was measured during this investigation by placing phantoms of Masonite presdwood, ranging in thickness from 10 to 20 cm., in a roentgen beam with the tube operating at potentials extending from 50 kv. (peak) to 150 kv. (peak). The filtration in the roentgen beam included only an inherent tube filtration of 0.5 mm. Al. The dosage rate received by the phantom was measured by a Victoreen ionization chamber placed directly in the center of the incident beam and in apposition with the phantom (i.e. the measurements included backscatter). A Patterson Type "B" roentgenoscopic screen was placed in the center of the emergent beam and its brightness measured by a photo-electric intensitometer. Since the spectral distribution of the light emitted by the screen is constant, regardless of the characteristics of the exciting roentgen radiation, values of screen brightness, measured by the intensitometer, are proportional to those which would be recorded visually.

Measurements of dosage rate and screen brightness were made with irradiated portal areas of 300 and 900 sq. cm. both with and without a grid. The efficiency of the grid employed in the investigation was 80 per cent.

After the collection of the data for the various conditions tested, the ratios of the relative brightness of the screen to the dosage rate received by the phantom were calculated. These values are shown plotted

as a function of peak kilovoltage in Figure 8. It is clear that regardless of the conditions of examination the ratio is low at low kilovoltages, rises rapidly to a maximum and then diminishes somewhat at high kilovoltages. The kilovoltage at which the maximum level is reached varies somewhat from one condition to another but it is usually not far from 120 kv. (peak). It therefore appears that if a given screen brightness is maintained in roentgenoscopy the patient will receive a relatively high roentgen dosage on his skin at the entrance portal when the roentgen tube potential is low. This dosage may be effectively decreased by raising the voltage to levels approaching 120 kv. (peak) and it therefore seems wise to perform roentgenoscopic examinations at or near this voltage as a matter of routine. It must be pointed out, however, that even at 100 kv. (peak) the dosage rate is very near its minimum value and excellent results therefore may be achieved at this voltage.

#### DISCUSSION

From the data presented in the foregoing portions of this paper it is evident that voltages higher than those now provided in diagnostic roentgen equipment (i.e. higher than 100 kv. (peak)) do not provide the roentgenologist significant benefits in either general roentgenography or roentgenoscopy. Image detail will not be improved nor will there occur any worthwhile reduction in the dosage received by the patient during roentgenoscopy if voltages above 100 kv. (peak) are used routinely. In chest roentgenography, photofluorography and spot-filming roentgenoscopy, how-

ever, kilovoltages in excess of 100 kv. (peak) do provide a number of advantages. Portions of the chest, especially the apices, hidden behind bony structures at low voltages, may be clearly perceived when the kilovoltage is high, particularly when aluminum filtration and a grid are used. The roentgen tube in photofluorography and spot-filming roentgenoscopy will also operate considerably cooler under a given schedule when the voltage applied to it is high.

It is difficult to speculate on whether or not the advantages of kilovoltages higher than those now available are sufficient to warrant the expense of providing them. It seems likely, however, that small and moderate sized laboratories, where most of the country's diagnostic roentgenology is done, will continue to operate within the kilovoltage range now provided. The larger laboratories of the country will almost certainly demand equipment providing higher voltages, such equipment probably being manufactured to special order.

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# THE BIOLOGICAL MEASUREMENT OF THE DEPTH DOSE OF ROENTGEN RAYS WITH LETTUCE SEEDLINGS

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THE effective dose in roentgen therapy is a function not only of the distance between the tumor and the roentgen tube, but also of the depth of overlying tissue. These relations have been studied by irradiating a biological indicator through substances with scattering and absorbing properties resembling those of living tissue. In an extensive experiment of this type, Henshaw and Francis<sup>4</sup> measured the root growth of lettuce seedlings which had been irradiated through different thicknesses of paraffin. An analysis\* of their published data for two levels revealed a problem of considerable biometrical interest. Subsequently a transcript of the entire experiment was obtained from Dr. Henshaw and improved methods of analysis for slope-ratio assays were developed<sup>1</sup>. In the light of this later information the complete material has been recomputed for its bearing upon the design and analysis of similar experiments.

The present experiment is essentially a biological assay. Its objective was to compare the potency of roentgen rays on living tissue imbedded in paraffin with that expected for transmission through air and after absorption by paraffin. In most biological assays some function of the response is related linearly to the logarithm of the dose, at least in the central portion of the dosage-response curve. In many cases a suitable function is selected empirically in the absence of a biological hypothesis relating dosage and response. With radiation, however, a rational approach is available in the theory of the random hit. The present paper is concerned with testing the agreement of the results obtained by Hen-

shaw and Francis with the hypothesis of a random hit. From the terms computed on the basis of this hypothesis we will then examine the relation between the observed potency of roentgen rays at various depths with the potency expected in air and after absorption by paraffin.

## APPLICATION OF THE HYPOTHESIS OF A RANDOM HIT TO ROOT GROWTH

The hypothesis of a random hit<sup>2</sup> assumes that the toxic effect of radiation can be attributed to the impact of one or more quanta of energy upon the "vital center" of a cell. If its reproductive capacity were destroyed by one quantum, the number of cells inactivated in a unit of time under uniform radiation would be directly proportional to the number exposed to injury. In this case the logarithm of the number of survivors would plot as a straight line against the exposure time. If more than one hit were required to disable a cell, the curve would be initially convex. Hence the number of hits needed per cell can be estimated from the shape of the curve and either a straight line or convex curve on these coordinates would be consistent with the hypothesis.

In applying this hypothesis to the lettuce root tip, the growth in length following irradiation is assumed to be proportional to the number of cells which survive. Root length in logarithms plotted against exposure time in minutes should define either a straight line or a convex curve, depending upon the number of hits required to knock out a single cell. A linear relation between these two variables, of course, would not prove the hypothesis of a single hit. Some

\* Reported by the author at the meeting of the Biometrics Section of the American Statistical Association in Chicago in December, 1940.

*a priori* evidence, in fact, is against it. Under this assumption the cells not hit in a vital spot would be unaffected and would grow at the same rate as untreated cells. At the dosages in the present experiment, however, all cells must have had ion pairs produced within them. Since irradiation is known to retard the rate of mitosis, the rate of multiplication and growth of all cells may have been delayed uniformly. Either retardation alone or the inactivation of a given proportion of the cells might lead to a linear relation between log-growth and exposure time. In the absence of other evidence, agreement with the theory of a random hit does not constitute proof of the hypothesis.

*Experimental Data.* The experiment with which we are concerned<sup>4</sup> consisted of 17 complete tests or replicates. A "phantom" was prepared from 8 discs of paraffin 30 cm. in diameter and 3.15 cm. thick, which were stacked on top of one another. A circular cavity 5 cm. in diameter and 2 mm. deep was cut in the upper surface of the second to the sixth discs to hold the seeds. Lettuce seeds just beginning to germinate were placed on 5 sectors of washed filter paper on top of the stack and in the cavity of the 5 succeeding discs. The different distances from the tube and in the phantom have been designated as levels *A* to *F* inclusive, *A* being that at the surface. At intervals of forty-five minutes during irradiation one sector with its seeds was removed from each level to obtain exposures of 45, 90, 135, 180 and 225 minutes respectively. The treated seeds and an untreated control were then germinated at 36°C. for ninety-six hours and the total length of 25 primary roots measured from each sample.

The roentgen rays were obtained from a standard tungsten-target, water-cooled 200 kv. roentgen tube of the Coolidge type. The center of the target was placed 50 cm. above the upper surface of the paraffin phantom where the rays covered a field of 400 sq. cm. Conditions were adjusted to give a radiation intensity of 12.2 r/min. at

the surface after passing through a filter of 3.23 mm. of copper and 2.4 mm. of celluloid.

The original measurements in millimeters are given in Table I. As a first stage in the analysis each was converted to its common logarithm. The mean log-responses for the 17 tests are shown in Table II and plotted in Figure 1. In test 11, data were not available for exposures of 180 minutes at levels *A* and *B*. To restore the balance of the experiment, the two missing values were estimated from the other results for the same level and test.

*Computation of the Descriptive Equations.* The observations plotted as means in Figure 1 were described numerically by computing a series of 6 straight lines with a common intercept at zero time. In determining their equations by least squares, each measurement was assumed to have a potential variability independent of the expected response and hence was given unit weight. This assumption simplified the calculation so materially that it has been retained, even though further analysis has shown its limitations in the present case. The equations were computed not only from the means of the 17 tests but also separately from the data of each replicate. Each series of equations had the form

$$\begin{aligned} Y_A &= a' - b_A X, \\ Y_B &= a' - b_B X, \\ &\vdots \\ Y_F &= a' - b_F X, \end{aligned} \quad (1)$$

where  $X$  was the length of exposure to radiation,  $Y$  the log-growth of seedlings,  $a'$  the value of  $Y$  at  $X=0$  or the common intercept and  $b$  the slope at each level.

The computation could be greatly simplified because of certain restrictions in the experimental design. These were (a) equal intervals between the successive periods of treatment beginning at zero exposure, (b) a complete set of observations in each test and (c) an approximately linear relation between response and exposure time. For analysis the time or dose was coded by

substituting 0, 1, 2, 3, 4 and 5 for treatment periods of 0, 45, 90, 135, 180 and 225 minutes. Since all levels had the same code the coded slopes have been used in later calculations.

The curves for the different levels were computed with two basic equations.<sup>1</sup> The

first was that for the common intercept of a single test or

$$a' = \frac{2(2k+1)T_v - 6T}{N(k-1) + 3h'(k+1)} \quad (2)$$

With  $k=5$  doses at each level,  $h'=1$  negative control and a total of  $N=31$  observa-

TABLE I

ORIGINAL DATA ON LINEAR GROWTH IN MILLIMETERS OF 25 ROOTS FROM LETTUCE SEEDS IRRADIATED FOR 5 DIFFERENT EXPOSURE PERIODS AT 6 LEVELS IN A PARAFFIN PHANTOM.  
EXPERIMENTS BY HENSHAW AND FRANCIS<sup>4</sup>

Test No.	Untreated Control	Minutes Exposed at Level A					Minutes Exposed at Level B				
		45	90	135	180	225	45	90	135	180	225
1	892	580	508	451	387	310	580	530	507	412	403
2	930	768	619	483	416	357	778	737	661	595	516
3	904	633	531	361	312	227	736	614	529	378	356
4	979	650	545	403	338	246	652	615	484	476	465
5	972	717	508	278	229	210	751	606	498	452	420
6	1087	882	716	534	386	332	935	794	713	614	461
7	1006	649	566	556	431	328	661	578	568	435	336
8	845	678	604	481	367	328	684	634	496	437	396
9	923	643	506	416	339	235	654	512	427	390	310
10	724	443	412	322	279	242	499	424	352	332	322
11	933	677	452	264		212	749	550	376		272
12	929	517	425	334	247	188	529	522	511	352	271
13	921	540	279	176	146	116	641	481	354	260	209
14	953	658	513	238	205	177	680	640	568	404	249
15	1033	634	563	215	172	162	783	690	442	348	281
16	849	678	535	318	255	230	741	622	420	336	287
17	952	752	427	280	182	179	782	660	526	379	252

Test No.	Minutes Exposed at Level C					Minutes Exposed at Level D				
	45	90	135	180	225	45	90	135	180	225
1	584	538	524	417	414	599	549	525	425	420
2	800	749	696	627	528	817	790	760	648	538
3	770	617	562	422	420	800	634	590	513	449
4	659	618	580	537	507	696	655	599	581	564
5	774	708	646	549	428	825	750	736	554	543
6	950	854	721	659	610	1010	867	764	673	640
7	796	650	608	557	443	806	695	614	599	546
8	694	650	614	604	513	732	676	627	621	576
9	663	571	516	498	420	717	656	526	520	499
10	503	436	371	364	347	504	448	374	368	366
11	751	669	477	367	306	781	688	668	572	500
12	544	537	532	443	354	568	565	559	509	425
13	653	607	528	401	230	657	648	539	407	322
14	718	700	678	526	306	734	722	717	643	479
15	800	731	568	433	325	856	804	719	554	521
16	766	727	577	544	346	774	746	718	577	502
17	799	775	620	445	356	864	828	663	449	434

TABLE I—(continued)

Test No.	Minutes Exposed at Level E					Minutes Exposed at Level F				
	45	90	135	180	225	45	90	135	180	225
1	605	562	544	443	428	612	571	549	456	445
2	823	798	766	756	546	841	826	818	802	558
3	819	661	652	582	546	849	708	703	603	587
4	703	690	612	602	573	782	732	618	608	590
5	870	863	770	702	620	892	883	786	764	690
6	1013	924	803	790	749	1036	958	852	806	793
7	811	766	747	661	650	915	777	766	744	726
8	737	680	650	624	605	753	730	705	690	683
9	725	675	625	616	548	790	684	651	620	611
10	506	456	392	379	370	579	459	455	449	435
11	810	768	718	589	504	836	818	731	675	641
12	604	593	574	557	534	702	695	653	649	630
13	660	654	567	553	487	714	706	610	608	586
14	744	735	720	695	627	881	866	820	733	637
15	942	898	819	562	524	954	916	826	703	592
16	782	762	749	683	647	838	816	770	719	662
17	913	839	764	483	459	920	848	843	518	511

tions in a complete group, this simplified to

$$a' = \frac{11T_v - 3T}{71},$$

where  $T_v$  was the sum of the 31 responses ( $y$ ) in a single test and  $T$  was the sum of the products of each  $y$  with its corresponding coded dose over all levels. The slope for a given level such as  $A$  was equal to

$$b_A = \frac{3}{2k+1} \left\{ a' - \frac{2T_A}{k(k+1)} \right\}$$
$$= \frac{3}{11} \left\{ a' - \frac{T_A}{15} \right\}, \tag{3}$$

where  $T_A$  was the sum at level  $A$  of the products of each  $y$  with its coded dose. The slope for each of the other levels was computed similarly.

The seven statistics required in Equation (1) were computed from the data for each test or replicate with Equations (2) and (3). The corresponding terms for the entire experiment were determined from the means for the 17 responses to each treatment. The observed means and the lines computed from them have been plotted in Figure 1 with the intercept 0.933 and the slopes shown in the second column of Table III.

TABLE II

ROOT GROWTH OF 25 LETTUCE SEEDLINGS FOLLOWING ROENTGEN TREATMENT, IN TERMS OF LOG-DM. AVERAGED OVER 17 TESTS ( $=\bar{y}$ ); BASED UPON THE DATA IN TABLE I

Level in Paraffin Phantom	Distance from Tube cm.	Mean Response ( $\bar{y}$ ) at Minutes' Exposure of					
		0	45	90	135	180	225
A	50.00	.967	.810	.701	.534	.443	.362
B	53.35		.838	.773	.687	.601	.520
C	56.50		.852	.811	.757	.686	.593
D	59.65		.869	.834	.792	.728	.684
E	62.80		.879	.854	.823	.775	.738
F	65.95		.908	.877	.849	.810	.781

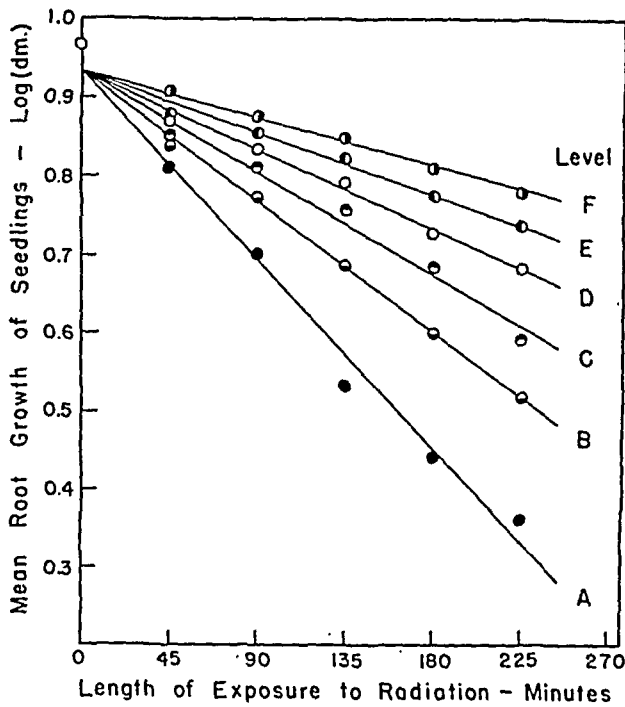


FIG. 1. Relation to length of irradiation in minutes of mean root growth in log-dm. of length of 25 lettuce seedlings at different levels in a paraffin phantom; data in Tables II and III.

#### AGREEMENT OF OBSERVATIONS WITH THE HYPOTHESIS

Visually the means plotted in Figure 1 seemed to agree quite well with the fitted lines. There was no evidence of the consistent convex curvature which would be expected if more than one quantum were needed to inactivate a cell. Hence the theory of a single random hit formed a suitable working hypothesis. Agreement with the hypothesis was tested by an analysis of variance in units of a single observation. The factors of biological interest were computed first from the means (or totals) in Table II. Each average effect was then compared with its variability in the 17 replicates or with the interaction of test by effect. The analysis has been summarized in Table IV. For ease of comparison all mean squares have been multiplied by  $10^5$ .

*Components of Variation in Testing Agreement.* The total variation among the means has been divided into four principal parts. The first was that accounted for by the seven constants defining the six straight lines in Equation (1). It has been entered

in the first row of Table IV. In the usual analysis of variance it would correspond to the correction for the mean plus the effect of each slope.

The second component was the discrepancy between the zero intercept and the mean response of the negative controls. As is evident from Figure 1, the negative control fell well above the point of intersection ( $a' = 0.933$ ). There may conceivably have been a different type of response with than without treatment. This possibility could be examined by the mean square

TABLE III

CONSTANTS FOR EQUATIONS FITTED TO THE DATA IN TABLE I. SLOPES GIVE CHANGE IN GROWTH ( $y$ ) FOR EACH UNIT (45 MINUTES) OF EXPOSURE TIME, WHERE  $y = \log\text{-dm. GROWTH}$ . GEOMETRIC MEANS ARE THE ANTILOGARITHMS OF THE VALUES IN THE LAST COLUMN

Level in Paraffin Phantom	Slope of Straight Lines			Mean log (100b)
	With control	Without control	Geometric mean	
A	.1201	.1184	.1141	1.0573
B	.0827	.0810	.0793	.8993
C	.0645	.0627	.0618	.7907
D	.0501	.0484	.0486	.6864
E	.0393	.0376	.0377	.5769
F	.0299	.0282	.0292*	.4652*

\* Aberrant low value in test 12 ( $-0.014$ ) replaced by missing-plot technique (0.410).

with 1 degree of freedom for the discrepancy between the negative control and the zero intercept.

A third component of variation was that due to non-convergence of the separate curves. As computed with Equations (2) and (3) the straight lines were forced to intersect at zero time. If each curve had been determined independently from the five exposure times at each level, six different values of  $a'$  would have been computed instead of one. The additional constants would have accounted for more of the total variation. This additional variation measured the non-convergence of the separate curves at zero time.

The final component was the scatter of

TABLE IV

ANALYSIS OF THE VARIATION IN LOG-GROWTH ABOUT THE LINES FITTED TO THE DATA OF TABLES I AND II; ORIGINAL MEAN SQUARES MULTIPLIED BY  $10^5$

Variation Due to	From Treatment Totals for 17 Tests			Interaction: Test $\times$ Treatment		
	D.F.	Mean square	F	D.F.	Mean square	F
Equation relating response to exposure time	7	4334975	1515.7*	112	2860	24.18*
Discrepancy of negative controls	1	2339	7.50*	16	312	2.64*
Non-convergence at O-time of separate curves	5	108	1.43	80	76	0.64
Scatter of observations about line for level	(A) 3	1307	5.13*	47	225	
	(B) 3	89	0.70	47	128	
	(C) 3	587	4.81*	48	122	
	(D) 3	144	1.85	48	78	
	(E) 3	92	1.58	48	58	
	(F) 3	12	0.17	48	72	
A-F inclusive				286	118	1.00

\* Statistically significant.

the observations about the line computed independently for each level. If the individual observations at a given level had deviated similarly from the curves in all 17 tests, a straight line might prove an inadequate description of the relation between log-growth and exposure time. After computing the two constants of a straight line independently from the 5 observations at each level, 3 degrees of freedom remained for measuring the divergence from linearity. In Table IV these have been listed separately from each level, both for the mean responses and for the variability among the separate tests.

#### Computation of the Analysis of Variance.

The mean squares in Table IV were computed by dividing the sums of squares by their respective degrees of freedom. Two mean squares were determined for each component. The sum of squares for each item was computed first from the totals of all 17 tests. A parallel analysis was then calculated from the observations of each individual test. The sum of squares from the totals was subtracted from the total sum of squares over all 17 tests for the

same term to obtain each interaction or error sum of squares.

The sum of squares accounted for by the six equations fitted to the means of the 17 tests was determined as

$$[y^2]_Q = a'T_v + b_A T_A + b_B T_B + \dots + b_F T_F, \quad (4)$$

where  $T_v$  and  $T_A$  to  $T_F$  represented the totals over all 17 tests. To measure the variation in both position and slope from test to test,  $[y^2]_q$  was required. This was computed by solving Equation (4) with the values for each of the replicates in the right hand side of the equation. The difference between the total of these 17 sums of squares for the individual tests,  $S[y^2]_q$ , and that for the equation based upon the totals,  $[y^2]_Q$ , gave the sum of squares for the interaction of test by equation in the first row of Table IV.

The discrepancy at zero time was determined by recomputing the constants in Equation (1) without the negative controls. The term  $h'$  in Equation (2) was then equal to 0 and  $N$  to 30. As recomputed from the means of the 17 tests,  $a'$  equalled



0.927 instead of 0.933 and the slopes were somewhat smaller as shown in the third column of Table III. The first entry in Table IV with 7 degrees of freedom represented the equations computed from all 31 mean observations. The variation about these 6 straight lines had  $31-7=24$  degrees of freedom. When the equations were recomputed from the 30 means without the control, 23 degrees of freedom remained in the variation of the treatment means about the six fitted lines. The difference between the two residual sums of squares with 1 degree of freedom measured the discrepancy of the mean of the negative controls from the zero intercept.

This process was then repeated for each individual test, the difference in the residual variation about the two sets of equations aggregating 17 degrees of freedom over all 17 tests. Subtracting the corresponding term based upon the means led to the mean square with 16 degrees of freedom for the variability in the discrepancy.

To obtain the sum of squares for non-convergence at zero time a straight line was computed independently from the five responses at each of the 6 levels. Two constants were determined for each line, the mean response for all five exposure times ( $\bar{y}$ ) and the slope ( $b$ ). The latter could be determined most readily by replacing the successive coded doses with the orthogonal coefficients for five doses,  $x' = -2, -1, 0, 1, 2$  respectively. For each replicate the product of the coefficients and the corresponding values of  $y$  gave the required slope

$$b = \frac{S(x'y)}{S(x'^2)} \quad (5)$$

The sum of squares attributable to  $\bar{y}$  and  $b$  at each level with 2 degrees of freedom was then equal to

$$[y^2]_{q'} = \frac{S^2(y)}{N} + \frac{S^2(x'y)}{S(x'^2)} \quad (6)$$

Over all 6 levels the total sum of squares had 12 degrees of freedom. Subtracting the sum of squares attributable to Equation

(1) computed without the controls gave for each replicate a difference with  $12-7=5$  degrees of freedom for the non-convergence of the individual lines at zero time. Equation (6) was also solved from the totals for all replicates ( $T_d$ ) and then had the form

$$[y^2]_{q'} = \frac{S^2(T_d)}{fN} + \frac{S^2(x'T_d)}{fS(x'^2)}, \quad (6a)$$

where  $f=17$ . The total sum of squares for the 17 individual tests diminished by the over-all sum of squares for the means or totals gave the required interaction sum of squares.

The remaining terms in Table IV measured the scatter of the observations about the lines determined with Equation (5). The residual variation of the individual observations for each level in a single test was computed as

$$[y^2]_r = S(y^2) - [y^2]_{q'}, \quad (7)$$

there being 17 such terms at each level. For the corresponding variation of the means Equation (7) was modified to

$$[y^2]_R = \frac{S(T_d^2)}{f} - [y^2]_{q'}, \quad (7a)$$

also with 3 degrees of freedom. The mean squares from Equation (7a) have been listed in the first column of Table IV. The difference between the sum of the 17 values determined with Equation (7) and that determined with Equation (7a) at each level led to the mean square for the interaction of test  $\times$  treatment.

*Interpretation of the Analysis of Variance.* The mean squares in the analysis of variance in Table IV which were statistically significant have been marked with an asterisk. Each component isolated from the treatment totals or means had its individual error in the same line of the table. The first three interactions have been compared with the mean square for the remaining interactions. The equations based upon all of the means accounted for most of the variation in the experiment but those computed from the individual tests varied significantly from one another. For this

reason the latter have been examined in more detail in the last section.

The average negative control was significantly larger than would be expected and the discrepancy was not uniform from test to test. Unusually large negative controls in tests 1, 4, 10 and 12 accounted for three-fourths of the total sum of squares. In the other 13 tests the mean square for the discrepancy was 1.03 as large as the pooled error. Since the growth of the untreated seeds was consistent with that of irradiated seeds in the majority of replicates, the definitive equations have been based upon all observations, including the negative controls.

Perhaps the most critical test was that for non-convergence an essential requirement for the hypothesis of a random hit. The lines computed from the means of all replicates converged satisfactorily at zero time and the corresponding values for the individual tests agreed well with one another (line 3 in Table IV).

The agreement of the mean responses with straight lines was tested separately for each level. The departure from linearity exceeded that expected by chance at levels *A* and *C* but the other 4 levels were without systematic curvature. It is apparent from Figure 1 that the curvature in the means for level *A* was concave and that for level *C* convex, the two trends balancing one another. Hence straight lines could be accepted as descriptive of the true relation and the hypothesis of a single-hit adopted in preference to that of a multiple hit.

The scatter of the observations about the lines for levels *A* to *F* decreased with the intensity of radiation. Since the heterogeneity of the 6 interaction mean squares was significant ( $\chi^2=36.67, n=5$ ), the comparison of the first three interactions with their pooled value was of limited validity. For full efficiency the individual observations should be weighted by the reciprocal of their expected variances in computing the basic equations instead of giving each an equal weight. This would apply not only to different levels but also to different exposure periods within each level. From

scrutiny of the observed values, however, we would not expect a more thorough analysis to alter any of the above conclusions.

The dependence of the error variance upon the response reveals an important limitation in slope-ratio assays. When the levels or samples differ markedly in potency, heteroscedasticity may lower the efficiency of the simple least square solution. Moreover, when the equations for the separate replicates differ markedly, as in the present experiment, the estimation of suitable weights to correct this factor may be difficult if not impossible. An attempt to develop weights from the present data, in fact, led to conflicting results for the different levels. Alternatively, the experimental design may be modified so as to reduce the discrepancy. If the dosage-interval (exposure time) had been increased from one level to the next on the basis of the first few replicates, the *coded* slopes would have differed but little in magnitude. This adjustment would have minimized the error introduced by treating each observation as of equal weight and increased the precision of the experiment.

#### RELATION BETWEEN RADIATION INTENSITY AND BIOLOGICAL POTENCY

The potency of the radiation at any given depth in the paraffin phantom could be computed from the ratio of its slope to that at level *A* or the surface. Smaller potencies would be expected at greater distances from the tube, quite apart from any absorption by the paraffin. Instead of computing the relative potency at each level, it was of more interest to relate the biological effectiveness of the radiation to its potential intensity in air from the data for all depths. The slope at each level and the radiation intensity were first converted to logarithms since in those terms the data were more uniformly variable and more nearly linear than in the original units.

The intensity of the radiation at the surface of the phantom was 12.2 roentgens per minute ( $I_A$ ). This decreased as the square

of the distance from the target of the roentgen tube. Apart from absorption by the paraffin, the intensity at any given level,  $i$ , could be expressed as

$$\log I_i = \log I_A - 2 \log (d_i/d_A), \quad (9)$$

where  $d_A$  and  $d_i$  were the distances in centimeters of levels  $A$  and  $i$  from the target. The log-intensity of radiation expected in air at each level has been computed from Equation (9) as shown in the fourth column of Table v. The response in units of  $\log (100b_i)$  has plotted against  $\log I_i$  and fitted with a straight line. Its equation was  $\log (100b_i) = 0.3693 + 2.453 \log I_i$ . At the surface of the phantom where  $\log I_i = 1.0864$ , the expected response was 1.0718. By adding the difference between these terms,  $1.0864 - 1.0718 = 0.0146$ , to each  $\log (100b_i)$  the biological potencies were converted to the log-roentgens per minute in column 8 of Table v, and plotted in Figure 2. The effectiveness of the irradiation decreased in paraffin as the 2.45 power of the value expected in air or inversely as the 4.90 power of the distance.

The absorption and scattering of radiation depend upon the incident wave length and the composition of the absorbing material.<sup>6</sup> At 200 kv. the copper and celluloid filters in the present experiment would be expected to absorb nearly all wave lengths except those between 0.06 Å and 0.15 Å; for present purposes an average of 0.11 Å has been assumed. The paraffin of the phantom has been assigned the molecular formula of

$(CH_2)_n$  and a density of 0.89 gm. per cubic centimeter.<sup>3</sup> At 0.11 Å the mass absorption coefficient for paraffin has been computed as 0.164 from the values given by Victoreen<sup>6</sup> for carbon and hydrogen.

The direct radiation intensity  $I_f$  at each level was equal to that expected at its distance from the target, diminished by absorption in paraffin as computed by the equation

$$\begin{aligned} \log I_f &= I_i - 0.4343(0.164)Dx \\ &= \log I_i - 0.0634x, \end{aligned} \quad (10)$$

where 0.4343 converted natural to common logarithms,  $D$  was the density of the paraffin and  $x$  its thickness in centimeters. Level  $A$  was separated from level  $B$  by 3.15 cm. of paraffin and from each succeeding level by an additional 2.95 cm. of paraffin. The computed log-intensities  $I_f$  in roentgens per minute have been listed in Table v and plotted in Figure 2. The curvature in the plotted points has been disregarded in fitting a straight line with a slope of  $b = 4.85$ . The intensity of direct radiation in paraffin decreased as the 4.85 power of that expected in air.

The biological potency of the radiation fell midway between that expected in air and the intensity of the direct radiation as computed from the mass absorption coefficient. The discrepancy arose from the biological effectiveness of the scattered radiation which was measured directly by Henshaw and Francis<sup>5</sup> in another experiment. They compared the growth of lettuce

TABLE V

COMPUTATION OF INTENSITY OF DIRECT RADIATION IN ROENTGENS PER MINUTE EXPECTED IN AIR AND AFTER ABSORPTION BY PARAFFIN AND OF THE CORRESPONDING BIOLOGICAL POTENCIES

Level	Distance from Target cm.	Log $d_i/d_A$	Intensity of Radiation in Air $\log I_i$	Thickness of Paraffin cm.	Direct Radiation $\log (r/min)$	Response $2. + \log b_i$	Biological Potency $\log (r/min)$
A	50.00	0	1.086	0	1.086	1.080	1.094
B	53.35	.0282	1.030	3.15	.830	.918	.932
C	56.50	.0531	.980	6.10	.593	.810	.824
D	59.65	.0766	.933	9.05	.359	.700	.714
E	62.80	.0990	.888	12.00	.127	.594	.609
F	65.95	.1202	.846	14.95	-.102	.476	.490

seedlings exposed to back-scattered radiation on the surface of the phantom with the growth following equal radiation at the same distance when suspended in air. Taking the response in air as 100 per cent, the back-scattered radiation from the paraffin increased the potency by 68 per cent. An even greater effect would be expected in the body of the phantom. The slope of the logarithm of the biological potency plotted against that computed for direct radiation was  $b=1.97$ . The biologically effective radiation increased as the square of that which reached the seeds directly from the target of the tube without deflection by the paraffin.

#### VARIABILITY AMONG TESTS

The equations describing each individual test differed quite significantly. The intercepts measuring the log-growth expected without treatment are given in the second column of Table VI. Although these ranged from 0.750 to 1.041, this variation should not affect directly the response to roentgen rays. The variation in slope was of more consequence, since the relative potency of the roentgen rays in paraffin was determined from the ratio of the slopes. It has been examined in a second analysis of variance. The slope, however, was less variable at greater depths in the phantom. By analogy with other biological assays, the slope at each level in each of the 17 tests was converted to  $z = \log(100b_i)$  as used in the preceding section and this stabilized the variance. In Test 12 the observed  $z$  at level  $F$  was  $-0.014$  when 0.410 would be predicted by the missing-plot technique. The latter value was substituted with a marked decrease in the error and an increase in the homogeneity of the entire experiment.

The log-slopes ( $z$ ) were related to the log-density of radiation expected in air in a new series of 17 dosage-response curves. The log-density at each level in the paraffin phantom was that listed in the fourth column of Table V and the corresponding mean log-slope that in the last column of Table III. As would be expected the anti-logarithms of these means or the geometric

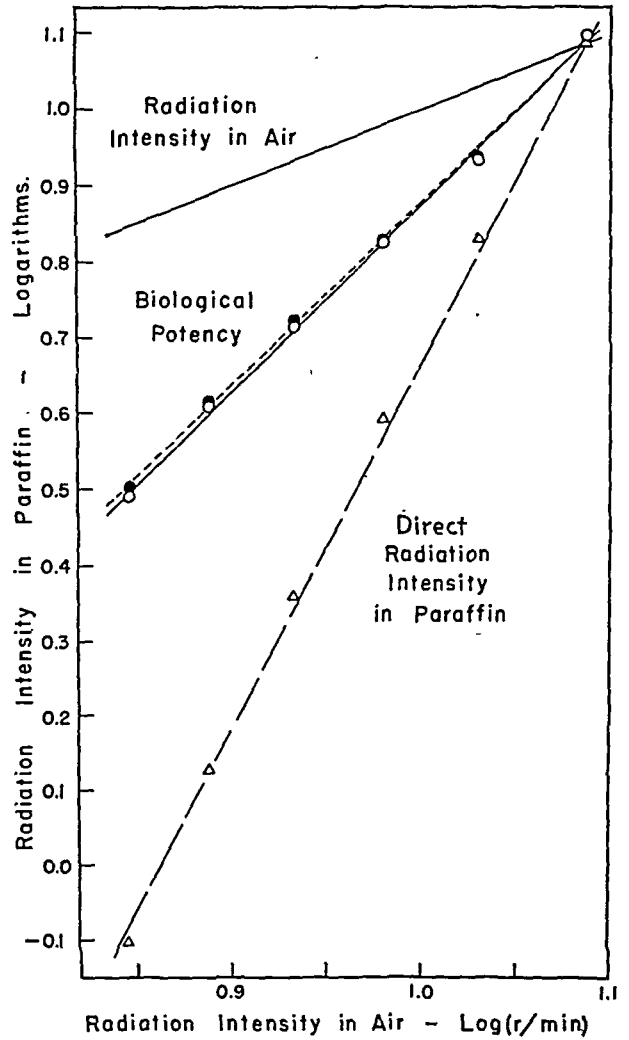


FIG. 2. Relation of biological potency of roentgen rays in  $\log(r/\text{min.})$  to intensity of direct radiation in  $\log(r/\text{min.})$  in air and in paraffin; data in Tables III and V.

means in the adjacent column were smaller than those for the general equation. Hence the factor converting mean  $\log(100b)$  to  $\log(r/\text{min.})$  was larger than before,  $+0.0371$  instead of  $+0.0146$ . The converted values have been plotted as solid circles in Figure 2 and fitted with the broken line.

The series of straight lines for the 17 tests were compared by the analysis of variance in Table VII. The first row compared the means in the individual tests of the log-slopes ( $z$ ) at all 6 levels. The second row accounted for the slope of the dotted straight line in Figure 2 and the third row for the scatter about it of the means for each of the 6 levels. The interaction of test

TABLE VI

CONSTANTS COMPUTED FROM EACH OF 17 INDIVIDUAL TESTS BY SOLVING EQUATIONS (2) AND (3) WITH 31 OBSERVATIONS

Test No.	From Relation of Log-Growth (y) to Exposure Time			Slope log (100b) vs. log-intensity
	Intercept $a'$ or y at 0 min.	Standard deviation, s n = 24	Mean log (100b)	
1	.844	.0298	.696	.78
2	.969	.0300	.661	1.67
3	.944	.0224	.800	2.04
4	.897	.0306	.629	2.20
5	.971	.0346	.736	3.10
6	1.041	.0167	.726	2.11
7	.943	.0286	.647	2.84
8	.898	.0170	.543	2.88
9	.901	.0244	.708	2.55
10	.750	.0337	.660	1.65
11	.960	.0370*	.840	2.77
12	.850	.0407	.691†	2.79†
13	.912	.0513	.892	3.05
14	.969	.0569	.794	3.17
15	1.028	.0513	.928	2.48
16	.956	.0341	.755	3.14
17	1.033	.0508	.977	1.75
Average	.933	.0366	.746	2.41

\*  $n=22$ .

† Aberrant low value (level F) replaced by missing-plot technique.

by log-density of radiation has been divided into two parts, the variability in slope from test to test and the random scatter of the individual variates (z) about the fitted lines. These are given in the last two rows of the table.

The seeds varied significantly in their

susceptibility to radiation as measured by the positions of the 17 lines. The mean log-slope ranged from 0.543 to 0.977 (fourth column of Table VI). Although the mean square for position was larger than that for slope, the slope also varied significantly from test to test as is evident from the ratio

TABLE VII

ANALYSIS OF VARIANCE OF THE RELATION OF BIOLOGICAL EFFECT TO LOG-INTENSITY OF ROENTGEN RAYS IN AIR, WHERE EACH RESPONSE IS LOG (100 $\frac{1}{2}$ ) FOR A SINGLE LEVEL IN ONE TEST. THE MEAN LOG-SLOPES ARE GIVEN IN THE LAST COLUMN OF TABLE III. AN ABERRANT LOW VALUE (TEST 12, LEVEL F) HAS BEEN REPLACED BY THE MISSING-PLOT TECHNIQUE

Variation	D.F.	Mean Square	F	
Between tests	16	.078378	38.80*	4.35*
Slope of straight line	1	3.961419	—	220.05*
Means about straight line	4	.001637	0.81	—
Parallelism of slope between tests	16	.018002	8.91*	1
Remainder or error	63	.002020	1	

\* Statistically significant.

of the last two mean squares in Table VII. The slopes have been listed in the last column of Table VI; they ranged from 0.78 to 3.17 and averaged 2.41. Hence there was a marked variation both in the average rate at which seedling growth was depressed by increasing the period of irradiation and in the effect upon this rate of the potency of roentgen rays after passing through paraffin. Since the same paraffin discs and the same roentgen tube were used in all tests, this suggests variation in the proportion of cells at a stage where they could be disabled from the impact of a quantum of energy. The variable rate at which the paraffin reduced the biological potency of the roentgen rays in the different tests could be demonstrated but has yet to be explained.

The interrelations between the terms for the 17 tests in Table VI have been examined, in part from their partial correlations. The larger the intercept in the original sets of equations, the greater was the mean log-slope ( $r=0.58$ ,  $n=14$ ), so that the larger the growth without treatment the greater was the reduction in growth by irradiation. The mean log-slope was also correlated with the standard deviation (with 24 degrees of freedom) about the original sets of equations ( $r=0.71$ ,  $n=14$ ). Hence greater susceptibility to roentgen rays was paralleled by greater variability in the response. None of the other correlations between the variables listed in Table VI proved significant. The additive factor for converting  $\log(100b_i)$  to  $\log(r/\text{min.})$  could be computed for each test from the last two columns in Table VI. It ranged from  $-0.188$  to  $0.292$  and was, of course, negatively correlated with the slope.

#### SUMMARY

The data of an experiment on the biological effectiveness of roentgen rays in a paraffin phantom have been re-examined for their agreement with the theory of a random hit. On the assumption that the root growth of irradiated seeds was propor-

tional to the number of cells surviving treatment, the logarithm of root length has been plotted against the length of exposure. The observations at the 6 different levels in the paraffin phantom could be fitted by straight lines which converged at zero time, in agreement with the hypothesis of a single hit. The biological effectiveness of the irradiation decreased in the paraffin as the 2.45 power of the value expected in air but the intensity of direct radiation decreased as the 4.85 power of the value in air. From this it is concluded that scattered radiation accounted for one-half of the total effectiveness of roentgen rays in paraffin. An analysis of the 17 replicates in the experiment disclosed a significant variability in respect to both average susceptibility and the rate at which the potency fell off in the phantom.

I am indebted to Dr. P. S. Henshaw for the original data upon which this paper is based, to Dr. C. P. Winsor for suggesting the hypothesis of the random hit, to Dr. E. C. Pollard for aid in computing the intensity of the direct radiation and to all three men for their helpful comments on my original manuscript.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Thirtieth Annual Meeting:* 1948, to be announced.



## STAPHYLOCOCCIC PNEUMONIA IN INFANCY AND CHILDHOOD

**S**TAPHYLOCOCCIC pneumonia in childhood has until recently been regarded as non-existent, or has been casually referred to in the literature as a variant type of pneumonia with an extremely high mortality. Indeed, most authors, in discussing this type of pneumonia, stress the high mortality. Not until recently has there been an increased interest in staphylococic pneumonia and this has probably been brought about due to an increasing emphasis on etiologic diagnosis. It has become apparent that because of therapeutic implications differentiation between the various types of pneumonia on an etiologic basis for the pneumonia may be of greater import than that based on clinical or anatomic features.

Quite recently Blumenthal and Neuho<sup>1</sup> have communicated their observations on forty proved cases of bronchogenous staphylococic pneumonia seen during a period of more than fifteen years. They call attention to the fact that the literature on staphylococic pneumonia is not large, and that the frequency with which the staphylococcus can be shown to be the etiologic organism in pneumonia differs with different age groups and that infants apparently are far more susceptible to invasion by this organism than children or adults.

They have observed that there is a definite seasonal incidence of cases of staphylococic pneumonia; the greatest number of cases are observed in the fall and winter months with a definite decline during the spring and summer months, and they have also observed that there is apparently a

relationship of staphylococic pneumonia to virus infections. In certain years and in specific localities the incidence of staphylococic pneumonia rises abruptly and this increased incidence usually coincides with an epidemic of influenza. Indeed this association between primary virus respiratory disease and staphylococic pneumonia was discussed by Chickering and Park<sup>2</sup> in their studies made during the course of a severe epidemic of influenza in an army camp in 1919.

Blumenthal and Neuho<sup>1</sup> state that the term staphylococic pneumonia should be reserved "for that form of suppurative bronchopneumonia in which bronchogenous invasion of the lung is presumed to have taken place."

Studies which have been made by them at autopsy and experiments dealing with the reproduction of the disease indicate that the infection descends from the upper respiratory passages and progressively involves the trachea and bronchi, extending by way of the lymphatics and interstitial tissues to reach the pulmonary parenchyma. This extension by the bronchial pathways accounts for the peripheral location in the lung of the suppurative lesion and also for the segmental distribution of the pathologic process. Blumenthal and Neuho<sup>1</sup> would stress this segmental feature which is so characteristic of bronchogenous spread with regard to staphylococic pneumonia as this characteristic feature has not been adequately emphasized.

In postmortem examinations they have noted, in addition, evidence of direct

<sup>1</sup> Blumenthal, S., and Neuho<sup>1</sup>, H. Staphylococic (suppurative) pneumonia in infancy and in childhood and its surgical aspects. *Am. J. Dis. Child.*, 1946, 72, 691-719.

<sup>2</sup> Chickering, H. T., and Park, J. H., Jr. Staphylococcus aureus pneumonia. *J.A.M.A.*, 1919, 72, 617. Quoted by Blumenthal and Neuho<sup>1</sup>.



spread from the bronchi to the pulmonary parenchyma and furthermore bronchial fistulas have been demonstrated in the great majority of their cases of staphylococcic empyema or of pulmonary abscess. This is further evidence that the pathway of the infection is bronchogenous.

They suggest that cases of staphylococcic pneumonia may be divided on a pathologic basis into two groups: those in which suppuration plays a minor role, as in the acute fulminating cases when abscesses have little time to form, and those in which suppuration is prominent. When suppuration does take place the abscesses are often multiple and are arranged in clusters about bronchioles and at times these may coalesce to form a large solitary pulmonary abscess. The location of these abscesses toward the periphery of the lung and their restriction to bronchopulmonary segments are features of considerable significance. Empyema or pneumothorax secondary to rupture of a pulmonary abscess is a frequent complication, with a decided tendency toward the formation of adhesions with the development of loculations and the walling off of staphylococcic pleural infections. A sudden blow-out of a pulmonary abscess may develop and air and pus in the pleura become so extensive and under such great tension as to break through pleural adhesions and the entire pleural cavity may thus be involved.

The roentgenographic features of staphylococcic suppurative pneumonia, Blumenthal and Neuhof state, are often distinctive but they are not pathognomonic. In a previous communication, Neuhof and Touroff<sup>3</sup> called attention to one roentgenographic feature which is characteristic of all suppurative pneumonias, namely the appearance of one or more areas of rarefaction in the midst of pneumonic infiltration. They pointed out that laminagrams may be necessary to reveal such areas in adults but that ordinary roentgenograms

somewhat overexposed are sufficient for the examination of infants and young children. The characteristic areas of rarefaction are visible sooner or later in the greater majority of cases of staphylococcic pneumonia in childhood. They are more commonly encountered than in suppurative pneumonias associated with mixed bacterial flora and one of the striking characteristics is that these areas of rarefaction may appear in a roentgenogram taken a day following one which did not reveal any area of rarefaction. Blumenthal and Neuhof emphasize this feature because its presence virtually proves the pneumonia to be caused by the staphylococcus when it is encountered in an infant and makes the diagnosis probable when it is encountered in a young child. "Other roentgenographic features of importance in staphylococcic pneumonia are, first, shadows corresponding to infiltrations about bronchi, blood vessels and interlobular septums; second, changes indicating the presence of focal, segmental or even lobar types of atelectasis; third, densities of lobular, segmental or lobar type."

These observers emphasize the important clinical aspect of the roentgenologic picture of staphylococcic pneumonia, namely the rapidity with which changes in the roentgenograms of the chest occur. One roentgen examination may reveal an area of rarefaction in the midst of pneumonic infiltration; the following day the roentgenogram may reveal a large collection of fluid and air in the pleura which may completely obscure the pulmonary lesion. In other instances a homogeneous density noted in a roentgenogram may be followed shortly by the appearance of a pulmonary cavity with fluid level. In still other cases a collection of fluid and air with displacement of the mediastinum may comprise the first roentgenographic evidence that the pulmonary lesion is not a simple pneumonic one. They emphasize the fact that there is often the problem of differentiating between a suppurative lesion which is still confined to the lung and one which has

<sup>3</sup> Neuhof, H., and Touroff, A. S. W. Acute aerobic (nonputrid) abscess of lung. *Surgery*, 1938, 4, 728-754. Quoted by Blumenthal and Neuhof.

already invaded the general pleural or an interlobar space. These remarkably sudden changes noted in the roentgenograms are of considerable importance as they may occur in the presence of an unchanging clinical course. Only by frequent roentgenographic studies can these clinically significant changes in this type of pneumonia be dis-

covered. The taking of roentgenograms at judiciously spaced intervals can play an important part in contributing to an understanding of the development of the disease and of the therapeutic indications.

By such means may a diagnosis be suspected early in the disease at which time the proper therapy may be most effective.



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF THE ROENTGEN SOCIETIES\*

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#### AMERICAN ROENTGEN RAY SOCIETY

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#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1948, to be announced.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1948, to be announced.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1948, to be announced.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

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#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

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#### CHICAGO ROENTGEN SOCIETY

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#### CLEVELAND RADIOLOGICAL SOCIETY

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#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

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#### DENVER RADIOLOGICAL CLUB

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#### FLORIDA RADIOLOGICAL SOCIETY

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#### GEORGIA RADIOLOGICAL SOCIETY

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#### ILLINOIS RADIOLOGICAL SOCIETY

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#### IOWA X-RAY CLUB

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#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

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**NEW ENGLAND ROENTGEN RAY SOCIETY**

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

**NEW HAMPSHIRE ROENTGEN RAY SOCIETY**

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

**NEW YORK ROENTGEN SOCIETY**

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

**NORTH CAROLINA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

**OHIO RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

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**ORLEANS PARISH RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

**PORTLAND ROENTGEN CLUB**

*Secretary*, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

**RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**

*Secretary*, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

**RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

**RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.**

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

**RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

**RADIOLOGICAL SOCIETY OF NEW JERSEY**

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, New-

ark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, Shirley Savoy Hotel, Denver, Colo., Aug. 7, 8, 9, 1947.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

**SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

**SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

**SHREVEPORT RADIOLOGICAL CLUB**

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

**UTAH RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

**UTAH STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University

Hospital, and second six months at Toland Hall, University of California Hospital.

## CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA  
*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

## BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY  
Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)  
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES  
*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

## RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

## RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## SOCIEDAD PERUANA DE RADIOLOGIA

*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

## CONTINENTAL EUROPE

## SOCIÉTÉ BELGE DE RADIOLOGIE

*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

## CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

## POLISH SOCIETY OF RADIOLOGY

First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

## WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 39, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

## ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygina and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

## SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

# AMERICAN ROENTGEN RAY SOCIETY

## SECTION ON INSTRUCTION\*

B. R. KIRKLIN, M.D., *Director*

*Abstracts of Courses Offered*

Forty-eighth Annual Meeting

Haddon Hall, Atlantic City, New Jersey

September 16-19, 1947

President-Elect Edwards, with the approval of the Executive Council, has directed that the Section on Instruction be continued for the 1947 annual meeting. He has arranged his program so that the instruction courses will be given between the hours of 2:00 P.M. and 4:45 P.M. on Tuesday, Wednesday and Thursday, and 2:00 P.M. and 3:15 P.M. on Friday. Nothing else will be scheduled during these hours, thus allowing everyone at the meeting to attend the Instruction Courses each afternoon.

This Section presents for 1947:

1. Six special Sequential Courses, lettered "A" to "F," with a faculty of seven instructors and covering fifteen periods.
2. Seven single-period courses on Radiation Physics, with a faculty of seven instructors and covering seven periods.
3. Thirteen single-period courses on Therapeutic Radiology, with a faculty of thirteen instructors and covering thirteen periods.
4. Twenty-one single-period courses on Diagnostic Roentgenology, with a faculty of twenty-one instructors and covering twenty-one periods.

### GENERAL INFORMATION

#### Conference Periods

Tuesday, Wednesday, Thursday and  
Friday afternoons

First period.....2:00 to 3:15  
Second period.....3:30 to 4:45

#### Location

All courses will be given in rooms A to H located on the thirteenth floor of Haddon

Hall. Full information may be secured at the general registration desk which will be located on the Lounge Floor.

#### Code

The instruction periods will be designated with the following code:

T-1 Tuesday, first period.....2:00 to 3:15  
T-2 Tuesday, second period....3:30 to 4:45  
W-1 Wednesday, first period....2:00 to 3:15  
W-2 Wednesday, second period..3:30 to 4:45  
Th-1 Thursday, first period.....2:00 to 3:15  
Th-2 Thursday, second period...3:30 to 4:45  
F-1 Friday, first period.....2:00 to 3:15

(Familiarity with this code will  
avoid much confusion)

#### How To Secure Tickets for Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following the abstracts of the courses will be found a general order sheet. First, second and third choices for each period should be carefully selected as the number attending each course given during these periods will be limited to from thirty to forty persons. If directions as given on the order sheet are followed explicitly, errors in completing reservations will be minimized.

If you are requesting registration in one or more of the Special Sequential (continuous) Courses, please indicate for each period your second and third choices of individual single-period courses as substitutes—to avoid disappointment should the Sequential Courses be filled when your order is received.

It is possible for one to attend only seven periods of instruction, so the condensed

schedule should be noted carefully in arranging individual orders for tickets.

Reservations will be made in the order of receipt of the order forms. Those who are not members of the American Roentgen Ray Society will be charged a nominal fee of \$1.00 per period, or a maximum fee of \$5.00 for five or more periods. Full time graduate students in Radiology will be admitted without fee.

Previous to September 6, send orders to Rochester, Minnesota; after September 6, send orders directly to Dr. B. R. Kirklin, Haddon Hall, Atlantic City, New Jersey.

If the courses are not filled by the time of the meeting, tickets will be available at the registration desk on Sunday, September 14, and thereafter during the meeting.

#### Holders of Tickets

Those who do not have a proper ticket for the assigned course will not be permitted to enter the room. Pages will be assigned to each conference room to collect tickets.

#### Duplications and Repeats

Due to the anticipated heavy registration a few of the single-period courses will be duplicated by two or more instructors.

### SEQUENTIAL COURSES

#### COURSE A (2 periods)

Room: A                      Periods: W-2; Th-2  
RALPH S. BROMER, M.D., Philadelphia, Pa.

#### The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children

The time allotted will be spent in discussing the differential roentgen diagnosis of skeletal changes occurring in diseases of infancy and childhood. All such diseases cannot be included in the time available for the course. Case material will be chosen from the following list: congenital syphilis; rickets, infantile scurvy, tuberculosis, lead poisoning, the blood dyscrasias, xanthomatosis and allied conditions, osteogenesis imperfecta, achondroplasia, multiple enchondromata, multiple cartilaginous exostoses, metastases caused by neuroblastoma, osteo-

chondritis and endocrine disturbances. Wherever possible the early roentgen changes will be emphasized. The question of differential diagnosis will be approached from the standpoint of the predisposition of the various diseases to affect certain bones or certain areas of individual bones. Thus in the case of the long bones, differential roentgen signs of the disease processes in the epiphysis, the diaphysis, the metaphysis, the periosteum, cortex, etc., will be given in detail.

#### COURSE: B (2 periods)

Room: G                      Periods: Th-2; F-1  
S. W. DONALDSON, M.D., Ann Arbor, Michigan

#### Medical Jurisprudence as Applied to Radiology

This course will take into consideration the relationship between physician and patient and the various contracts entered into between them. Malpractice will be defined and consideration given to all acts of the radiologist that may be subject to allegation of negligence or other grounds for suit. The Law of Agency will be discussed and its application to the radiologist in regard to his liability for the acts of those employed by him. Pointers will be given about malpractice defense and prophylaxis. The legal requirements for the introduction of films as evidence in courts of law will also be taken up as well as that for physician's records and hospital records. There will be discussion of privileged communications as related to roentgen examinations, the admissibility of evidence, expert testimony, expert witness fees, and court room procedure for the witness.

#### COURSE: C (3 periods)

Room: A                      Periods: T-1; W-1; Th-1  
ROSS GOLDEN, M.D., New York City  
Roentgenology of the Small Intestine

#### Tuesday

Technique  
Normal small intestine  
Anatomy  
Physiology  
Indications for small intestine study  
Diverticula  
Disturbances in physiology  
Emotion  
Vagotonia  
Multiple peritoneal adhesions  
Developmental anomalies  
Internal hernia  
Congenital diaphragm

## Effect of disease of the mesentery

Localized

Generalized

Lymphoblastoma

Sclerosing mesenteritis

*Wednesday*

## The "Deficiency Pattern"

Vitamin deficiency states

Hypoproteinemia

Biliary tract disease

Pancreatic disease

Allergy

Inflammations

Tuberculous

Non-tuberculous

Sclerosing regional enteritis

Non-sclerosing regional enteritis

*Thursday*

Neoplasms

Benign

Malignant

Carcinoma and carcinoid

Lymphosarcoma

Localized

Diffuse

Benign ulcer

Ileus

Diagnosis by 3 position abdominal films

Paralytic

Mechanical

Mesenteric vascular occlusion

The Miller-Abbott tube

Technique of insertion

Deflation

Injection of barium for

1. Localization

2. Demonstration of type of obstruction

Complications

**COURSE: D**  
(2 periods)

Room: B

Period: T-2; W-2

**GEORGE W. GRIER, M.D., Pittsburgh, Pa.****The Diagnosis of Congenital Heart Lesions in Children**

Various malformations and congenital lesions of the heart will be discussed. Lesions which produce characteristic changes will be presented, as well as combinations of lesions. Other lesions in which the roentgen findings and clinical evidence combined will make a diagnosis will also be discussed. Films of a number of cases that have come to autopsy will be presented.

**COURSE: E**  
(4 periods)

Room: H

Periods: T-1; W-1; Th-1; F-1

**W. WALTER WASSON, M.D., Denver, Colo.**  
**The Anatomy, Physiology, and Mechanics of the Chest as a Basis for the Study of Chest Diseases and Their Classification**

This is an effort to portray the chest so that the clinician or radiologist can actually visualize the thoracic viscera and their diseases. A child begins life with certain anatomical structures which change with the years both as a result of a physiological processes and disease. The pathological reactions which the clinician or the radiologist is called upon to diagnose are definitely influenced by the particular physiology and mechanics of this anatomy. Accordingly, any classification of chest disease must be based upon the pathological reactions of disease as influenced by anatomy and of the physiology and mechanics of this anatomy.

The presentation will be made in the following sections:

- |  |              |
|--|--------------|
| 1. Anatomy of the Lungs  | Period: T-1  |
| 2. Physiology and Mechanics of the Chest and Particularly of the Lungs       | Period: W-1  |
| 3. The Classification of Diseases of the Lungs                               | Period: Th-1 |
| 4. Illustrations of the Different Diseases of the Lungs and their Diagnosis. | Period: F-1  |

**COURSE: F**  
(2 periods)

Room: C

Periods: T-2; W-2

**GEORGE M. WYATT, M.D., Washington, D. C.**  
**W. S. RANDALL, M.D., Washington, D. C.**  
**Benign and Malignant Lesions of Bone**

This material is selected from the cases admitted to the Walter Reed General Hospital in its capacity as a tumor center during World War II. Lantern slides include the roentgenographic, gross, and microscopic appearance of the various lesions.

Among the conditions to be considered are osteomyelitis, osteoid-osteoma, fibrous dysplasia, eosinophilic granuloma, giant cell tumor, lymphoma, chondrosarcoma, osteogenic sarcoma, Ewing's tumor, neuroblastoma, and myeloma.

Attention will be directed to correlation of the roentgen appearance and gross pathology and to differential diagnosis of benign and malignant lesions.



## SINGLE PERIOD COURSES

## RADIATION PHYSICS

## COURSE: 101

Room: G

Period: T-1

CARL B. BRAESTRUP, Ph.D., New York City

Common Causes of Radiation Hazards  
in Roentgenology

Radiation injuries are caused mainly by faulty equipment, inadequate structural shielding or improper operating procedures.

*Equipment.* Most improvements in roentgen-ray equipment have been in the direction of greater safety. Thus the protective tube housing practically limits the radiation to the useful beam. On the other hand, the important progress made in roentgen-ray tube design has so greatly increased the available dosage rate that permanent skin injuries may be produced in a few seconds. It is important, therefore, that roentgen therapy equipment be provided with accurate means for the control of the dose.

The protection afforded the patient, the radiologist and attendants during fluoroscopy depends to a large extent upon the construction of the fluoroscope. The use of large target-panel distances and adequate filtration reduces materially the exposure to the patient. The dose received by the fluoroscopist can be cut down considerably by proper diaphragming of the useful beam and ample shielding against scattered radiation.

*Structural Shielding.* The use of protective equipment has often produced a false sense of security especially where the equipment is represented as "ray-proof." Obviously barriers must be provided against the useful beam and resultant scattered radiation. Radiation injuries due to inadequate structural shielding seldom manifest themselves for years when permanent damage has already been done. No roentgen-ray installations, therefore, should be considered safe until so established by ionization measurements or similar tests.

*Operating Procedures.* Most radiation injuries can be ascribed to the failure of the human element, caused either by carelessness or lack of understanding of the protection problem. Fracture setting under fluoroscopy is probably the greatest cause of radiation injuries in diagnostic roentgenology. The greatest radiation hazard in therapy is the omission of the proper filter. Another frequent cause of overexposure of the patient is the incorrect use of ionization instruments.

Actual cases of radiation hazards will be presented to demonstrate that no roentgen-ray installation is safe unless properly used.

## COURSE: 102

Room: E

Period: W-1

G. FAILLA, Ph.D., New York City  
Dosage Problems in the Use of  
Radioactive Isotopes

Radioactive isotopes. Availability and possible uses as tracers and for therapy.

Discussion of physical characteristics (activity, half-life, type and energy of radiation).

Tissue dosage determinations: (1) when used in "applicators" as in the case of radium or radon; (2) when introduced into the body as chemical compounds.

Influence of rate of decay, elimination, local concentration.

Dangers in the use of radioactive isotopes internally administered.

Protection of personnel.

Dosage data and charts will be presented.

## COURSE: 103

Room: E

Period: T-2

GEORGE C. HENNY, M.Sc., M.D.,  
Philadelphia, Pa.Roentgen Film Characteristics and the Practical  
Calibration of Roentgenographic Apparatus  
and Processing Solutions

The characteristics of the roentgen film emulsion (together with intensifying screens if they are used), in which the roentgenologist is mainly concerned, are the "speed" and the "contrast." These characteristics are of great importance.

The "speed" determines the degree of darkening of the processed film, after standard development, for a given roentgenographic exposure and a particular anatomic part.

The "contrast," under the same conditions, determines the degree to which tissue density-differences and thickness-differences of the anatomic part will be recorded on the roentgenogram.

For uniformity of results the roentgenographic apparatus and processing solutions should be calibrated at regular intervals. Fairly simple methods of calibration, which are accurate enough for the purpose, are described and may be employed in the roentgen department without great outlay of time or money. When properly employed the roentgenograms of a given patient show uniform density from one examination to the next and the detail of the anatomic parts being studied is, as far as the film emulsion is concerned, brought out to the greatest degree.

**COURSE: 104**

Room: E

Period: Th-2

EDITH H. QUIMBY, Sc.D., New York City

**Dosage Calculations in Radium Therapy**

The development of dosage units for radium therapy will be traced briefly. Various charts and tables for determination of dosage in roentgens will be presented. Most of the period will be devoted to working out practical problems.

**COURSE: 105**

Room: G

Period: Th-1

LAURISTON S. TAYLOR, Ph.D.  
Washington, D. C.**Ionization Chambers and Their Uses**

A non-technical discussion will be given on the uses and limitations of various types of ionization chambers. The clinical applications of the thimble chamber will be discussed pointing out the limitations in its use, the methods of making corrections in measurements, and the general factors which enter into the measurements. The problem of measuring very soft roentgen rays by means of special ionization chambers will also be discussed. The measurement of megavolt radiation and gamma rays together with the instrumental limitations will be developed together with the means of applying corrections to the clinical measurements that may be made.

**COURSE: 106**

Room: G

Period: W-2

J. L. WEATHERWAX, M.S., Philadelphia, Pa.

**Dosage Calculations in Roentgen Therapy**

1. Comparison of roentgens measured in air, on the skin and at a depth in a phantom or tissue.
2. Factors influencing backscatter to skin portals.
3. Factors influencing penetration into the tissue.
4. Depth dose charts and a study of the intensity tables as found in "Physical Foundations of Radiology."
5. Study of contact therapy as to quality, penetration and radiation distribution.
6. A short discussion of supervoltage radiation therapy. (If time permits.)
7. Methods of estimating tumor dose in tissue roentgens.

**COURSE: 107**

Room: D

Period: F-1

MARVIN M. D. WILLIAMS, Ph.D.  
Rochester, Minnesota**Roentgen-Ray Circuits and Apparatus**

The effect of voltage and current and their wave forms on the quality and dosage rate of radiation will be briefly reviewed. The common circuits used in roentgenographic and therapy machines will be illustrated, and the voltage and current wave forms produced by each will be shown on an oscillograph. The effect on voltage wave form produced by certain changes in equipment will be shown and the resultant effect on radiation output discussed.

**THERAPEUTIC RADIOLOGY****COURSE: 201**

Room: C

Period: Th-1

E. C. ERNST, M.D., St. Louis, Mo.

**Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri****SYNOPSIS**

- (a) *Clinical Management and Preliminary Considerations*
- (b) *Indications for Roentgen Therapy:*
  1. Indirect irradiation of the pelvis.
  2. Direct (intravaginal) roentgen-ray applications.
- (c) *Essential Tumor Dose Measurement Factors*
- (d) *Indications for Radium Therapy:*
  1. Evaluation of the various methods and the intracervical applicators.
  2. Essential minimum requirements for obtaining the ideal uniform distribution of radium radiations.
- (e) *Prognostic Factors:*
  1. Tumor grading.
  2. Stage of the disease.
  3. Initial response to preliminary roentgen irradiation.
- (f) *Final Discussion Period:*
  1. Case presentations.
  2. Questions (15 minutes).

**ABSTRACT**

The practical irradiation management of carcinoma of the cervix will be discussed both from the standpoint of the institutional tumor clinic and the private office procedure. Although realizing that the radiation treatment standards continue to remain somewhat in a state of flux and that individualization in the application of roentgen rays and radium is a most essential consideration, nevertheless certain fundamental concepts in our routine procedures are

most helpful in the management of cancer of the cervix. These and many other practical therapeutic considerations, including external roentgen therapy, intracavity radium and roentgen methods of treatment and the dosage measurement problems, will be discussed and illustrated.

**COURSE: 202****Room: C****Period: T-2**

**HARRY H. BOWING, M.D.**  
Rochester, Minnesota

**Carcinoma of the Uterus and Radiation Therapy**

Carcinoma of the uterus may be recognized readily or all the efforts of an experienced physician may be necessary to make the diagnosis and to determine the probable site of the primary lesion. Carcinoma is an individual disease and the management and treatment must definitely be individualized to obtain a satisfactory rate of cure or palliative arrest of the disease. The demands made on a therapeutic radiologist may be those made on a diagnostician, a therapist or a consultant. The fundamental features of a proved method of treatment will be considered.

**COURSE: 203****Room: B****Period: F-1**

**MILTON FRIEDMAN, M.D., New York City**

**Supervoltage Roentgen Therapy**

The increasing use of supervoltage roentgen therapy necessitates reorientation of certain concepts in radiotherapy. Since skin damage is no longer a major obstacle, the principle of "giving as much as the skin can stand" is no longer a guide. It now becomes necessary to ascertain the specific lethal tumor dose for the lesion being irradiated, and the tolerance dose of the adjacent normal structures, which varies considerably for different organs.

Physical characteristics of a beam of supervoltage radiation will be discussed from the standpoint of clinical applications.

The methods of ascertaining the tumor dose of the lesion under treatment will be discussed, including principles of interpretation of quantitative cytologic destruction in biopsies taken during treatment.

Finally specific tumors will be discussed from the standpoint of (1) radioincurable lesions which are brought within range of radiocurability by supervoltage roentgen therapy; (2) lesions ordinarily treated with 200 kv., which can be more efficiently treated with supervoltage radiation; and (3) improved palliation obtained with supervoltage radiation.

**COURSE: 204****Room: B****Period: W-1**

**HAROLD W. JACOX, M.D., New York City**

**Complications Following Irradiation of the Pelvis**

The discussion will include those complications which are general and local, both immediate and late, of slight and serious consequence. Consideration will be given to details of the rate and methods of applying roentgen and radium therapy for pelvic lesions. The various organs involved will be evaluated from the standpoint of their tolerance to irradiation. The mechanism and management of these complications will be considered with a view to avoiding them if possible.

**COURSE: 205****Room: C****Period: W-2**

**H. DABNEY KERR, M.D., Iowa City, Iowa**

**Irradiation of Malignant Tumors of the Pelvis**

This will be a general discussion of the problem of delivering "adequate" doses of radiation to pelvic lesions, especially carcinoma of the cervix. It will necessarily have to include reference to basic physical problems or irradiation. The technique of irradiation in use currently at the State University of Iowa will be presented not as a fixed method but as one which seems to be working effectively. There will also be a discussion of local and general complications, including osseous damage.

**COURSE: 206****Room: B****Period: Th-2**

**MAURICE LENZ, M.D., New York City**

**Roentgen Therapy of Lymphosarcoma**

The result of roentgen therapy of lymphosarcoma varies with inherent clinical characteristics, microscopic structure, assumed primary site, extent on admission and tumor dosage.

A detailed analysis will be given of the experience with this treatment at the Presbyterian Hospital, New York.

**COURSE: 207****Room: D****Period: T-1**

**T. LEUCUTIA, M.D., Detroit, Mich.**

**Radiation Therapy of Bone Tumors**

(1) Osteogenic sarcoma. Radiation therapy is used in association with surgery in pre- or postoperative form in all types, except the pure osteolytic type, in which it is used alone. In the inoperable group, irradiation produces definite symptomatic

relief. The five year survival for the entire series amounts to 17 per cent.

(2) Giant cell tumor. Here radiation therapy is the method of choice. There are two requisites: (a) irradiation must be carried out with gradually decreasing doses for nearly two years, and (b) a limited use of the affected bone must be made so as to prevent marked demineralization from disuse. The final results are, with few exceptions, good.

(3) Ewing's tumor. In the very early cases, radiation therapy may lead to occasional five year survival; in the others, only palliation is obtained, although the immediate response is often striking.

(4) Multiple myeloma. Radiation therapy leads to limited symptomatic relief, but no cure is possible.

(5) In the group of benign tumors, radiation therapy is of definite value in chondroma, myxoma, hemangioma, cystic conditions, etc.

The detailed procedure is presented in the various groups and the technique of irradiation illustrated. Final statistical data are included.

between the types, is responsible for variation of results from treatment. Comparison of the roentgen ray and radium. Complications during treatment. Difficulties encountered from previous forms of treatment, thickened scars, and keloids. Spontaneous ulceration, ulceration occurring during treatment. Complication from local lack of growth and function, deformity due to tumor, dermatitis, telangiectasis. Malignancy more likely in the pigmented variety. Treatment should be mild. Large masses upon the scalp should disappear and bald spots should be exceedingly rare. These tumors are usually more radiosensitive than hair. Discussion of treatment in the young infant, child and adult. Comparison with other types of treatment: surgery, electric modalities, caustics, injections of various solutions. General review of groups and individual cases, with emphasis upon bone changes observed in different types. Results observed immediately after treatment and ten to twenty years later. A plea for early treatment.

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#### COURSE: 208

Room: H

Period: W-2

CHARLES L. MARTIN, M.D., Dallas, Texas

##### Complete Care of Cancer of Mouth and Lip Including Cervical Metastases with Irradiation Alone

A plan for the complete radiological care of all stages of cancer of the mouth and lip will be described. Although both radium and roentgen rays are used, the equipment is relatively inexpensive and the time of treatment is short. Much emphasis will be placed on the intensive irradiation of metastatic cervical glands, using a combined roentgen-ray and interstitial radium technique, which has yielded some very promising results. Detailed descriptions of the procedure used in a number of actual cases have been prepared for presentation.

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#### COURSE: 209

Room: B

Period: Th-1

WILLIAM S. NEWCOMET, M.D.,  
Philadelphia, Pa.

##### Radium Therapy of Hemangiomata

The fact that hemangiomata occasionally disappear has led many physicians to defer treatment. Seventy per cent of these tumors enlarge shortly after birth; therefore treatment should be early, and thus save extension of the mass. Periodic growth. Portwine marks noticed at birth, rarely change in size and are not superficial. Pathologic difference,

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#### COURSE: 210

Room: C

Period: Th-2

G. E. PFAHLER, M.D., Philadelphia, Pa.

##### Radiation Treatment of Cancer of the Breast

The technique for the treatment of cancer of the breast cannot be standardized. The treatment will be demonstrated for cancer of the breast in various stages, including positioning of patient for treatment.

There will also be a demonstration of some of the cases treated primarily and completely by irradiation, also preoperative and postoperative irradiation, including the management of recurrences.

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#### COURSE: 211

Room: C

Period: F-1

GORDON E. RICHARDS, M.D., Toronto, Canada

##### Radiation Therapy of Malignant Tumors of Lips, Tongue and Mouth

This course will be a lecture demonstration illustrated by numerous kodachromes covering the most effective methods of treatment of primary malignant tumors occurring in the lips, gingivae, buccal mucosae, tongue and floor of mouth. While the course is intended to deal chiefly with the most satisfactory methods of treatment of primary lesions by means of radiotherapy, a discussion will also be included on the general problem of metastatic involvement of regional lymph nodes and the most suitable treatment of this complication.

**COURSE: 212****Room: D****Period: T-2****ROBERT B. TAFT, M.D., Charleston, S. C.****Dosage Measurement from a Clinical Standpoint**

The various methods in common use for measuring clinical roentgen-ray dosage will be discussed, and the advantages and disadvantages of each pointed out. The value of the roentgen as a clinical unit will be compared with formerly used units. Pros and cons for the direct dosage measurement on the skin of the patient throughout the treatment time will be given. Air measurements versus skin measurements will be outlined and tables given for backscattering at commonly used wavelengths. Brief mention will be made of methods of determining stray radiation around a laboratory, either medical or industrial. Half of the period will be taken up with the above and round table discussion will follow. Throughout, an earnest effort will be made to keep the matter within the scope of the clinical radiologist who has little knowledge of, or interest in, pure physical measurements. The instructor, having had experience in both clinical and physical work, will attempt to narrow the far-too-wide gap between the clinician and physicist.

**COURSE: 213****Room: F****Period: W-1****B. P. WIDMANN, M.D., Philadelphia, Pa.****Radiation Therapy in Cancer of the Skin**

Technical procedures for the radium and roentgen treatment of cancer of the skin will be reviewed and analyzed in detail. A definite predetermined plan of dosage has been formulated according to the estimated surface area and thickness of the lesion. Special emphasis will be placed on the value of low voltage roentgen rays (100-135 kv.), and a clinical comparison with radium will be made according to a great variety of patterns for single and multiple radium tubes with different sizes of fields, filters and distances. Conclusions will be drawn from a large clinical experience with massive and fractional doses. Determinations of the "maximum safe dose," the "minimal effective dose," the daily intensity and the probably best rate of administration will be considered with specific recommendations after a routine experience demonstrating results and skin tolerance.

**DIAGNOSTIC ROENTGENOLOGY****COURSE: 301****Room: D****Period: W-1****PAUL A. BISHOP, M.D., Philadelphia, Pa.****Examination and Diagnosis of Lesions of the Temporomandibular Joint**

The frequency with which injuries of the temporomandibular joint are overlooked, both clinically and roentgenographically, has led to an appalling number of permanent, serious disabilities of the mandible. A technique for the roentgenographic study of this joint is presented with lantern slide demonstration of acute and chronic injuries, as well as various non-traumatic conditions.

**COURSE: 302****Room: G****Period: T-2****FRANKLIN B. BOGART, M.D.,****Chattanooga, Tennessee  
Leukosarcoma**

The literature will be briefly reviewed and cases will be presented which illustrate the typical Sternberg syndrome with mediastinal tumor and other variations of borderline cases which present some features of lymphosarcoma and some features of leukemia.

**COURSE: 303****Room: F****Period: W-2****JAMES T. CASE, M.D., Chicago, Ill.****The Roentgenologic Diagnosis of Carcinoma of the Colon**

In the diagnosis of carcinoma of the colon the pathological and anatomical considerations vary according to the location of the tumor in the right or left half of the colon. In colonic polyposis the symptomatology, like the pathology, varies with the position of the tumor in the right or left colon. Special technique is a matter of utmost importance. Repetition of the examination is often necessary.

The technique of examination for and the roentgenologic manifestations of cancer of the colon will be discussed and illustrated.

**COURSE: 304****Room: F****Period: Th-1****ARTHUR E. CHILDE, M.D., Winnipeg, Manitoba****The Normal Encephalogram and Ventriculogram  
Congenital Abnormalities of the Brain**

The roentgen technique of cerebral pneumography

will be discussed and the importance of a few simple manipulations of the head during this procedure will be explained. This will be followed by a review of the normal anatomy of the ventricular system, basal cisterns and cortical markings. The pneumographic features of various congenital abnormalities will be shown.

### COURSE: 305

Room: F

Period: F-1

ARTHUR E. CHILDE, M.D., Toronto, Canada

#### The Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions

The deformities produced by various types of expanding intracranial lesions will be shown. Encephalography is often used to determine the cause of epileptic seizures in patients who do not suffer from brain tumors, and some examples of atrophic and contracting intracranial lesions will also be illustrated.

### COURSE: 306

Room: F

Period: T-2

ARTHUR C. CHRISTIE, M.D.,  
Washington, D. C.

#### The Diagnosis and Treatment of Bronchiectasis

History and Incidence.

Etiology and Pathogenesis.

*Diagnosis.*

Symptoms and signs. Necessity and means of early diagnosis. Iodized oils. Instillation of iodized oil by the passive method. Description of method. Illustrative slides to show different types of bronchiectasis and conditions which may require differential diagnosis.

*Treatment.*

Necessity for treating complicating inflammatory conditions. Medication. Postural drainage. Iodized oils. Bronchoscopic drainage.

Surgery: Applicability and limitations. Artificial pneumothorax. Phrenicectomy. Pneumectomy. Roentgen therapy: Rational basis for such treatment. Detailed descriptions of application, dosage, etc. Results illustrated by report of cases.

The aim of this course is to give a complete view of the diagnosis and treatment of this exceedingly common disease in which the radiologist can play an important role in both fields.

### COURSE: 307

Room: D

Period: Th-1

LEWIS GREGORY COLE, M.D.  
White Plains, N. Y.

#### Pulmonary Tubercles, Their Etiology, Pathogenesis, and Roentgen Shadows They Cast

These subjects will be considered in their reverse order, first showing roentgenograms of pulmonary tubercles, then demonstrating the pathological findings of various tubercles, illustrated with Kodachrome photomicrographs, and subsequently presenting the pathogenesis and etiology. This reverse manner of presenting the subject should appeal to roentgenologists more than the rational sequence in the reverse order.

### COURSE: 308

Room: E

Period: T-1

HOWARD P. DOUB, M.D., Detroit, Mich.

#### The Intervertebral Disc

This discussion will be limited as much as possible to the disc itself, but owing to its intimate relationship to the vertebrae, it will be necessary to consider the spine to some extent.

We wish to present the anatomy of the disc and its vascular supply together with reference to defects in its development which often lead to abnormalities in later life. Changes in the fibrous structure and in the cartilage plates, due either to disease or trauma, will be brought out. The effect of these changes on the vertebral column as a whole will then be considered.

The relationship of the disc to spinal deformities, such as the arthritides, kyphoses, tumors and injuries will also be discussed.

### COURSE: 309

Room: E

Period: Th-1

PEDRO L. FARIÑAS, M.D., Havana, Cuba

#### Bronchography

Bronchography: Technique: Serial bronchography; bronchography by vaporization: (a) supra-tracheal; (b) intratracheal.

Results: Especially in the early diagnosis of bronchial carcinoma.

**COURSE: 310**

Room: G

Period: W-1

**JOHN T. FARRELL, JR., M.D.,**  
Philadelphia, Pa.

**Roentgen Diagnosis of Lesions of  
the Esophagus**

The technique of roentgen examination of the esophagus with liquids, semi-solids, and solids, together with the indications and limitations of each will first be presented. This will be followed by consideration of the roentgen anatomy and physiology. Study of pathological states will embrace the diagnosis and differential diagnosis of congenital, inflammatory, traumatic, functional, and neoplastic conditions of the organ.

**COURSE: 311**

Room: H

Period: T-2

**C. A. GOOD, M.D., Rochester, Minnesota**

**The Small Intestine**

All of the lesions commonly encountered in the small intestine will be discussed. Special emphasis will be placed upon the diagnosis of the organic lesions which are amenable to surgical treatment, such as enteritis, Meckel's diverticulum and benign and malignant tumors.

Particular attention will be paid to the roentgenoscopic method of examination and there will be a brief consideration of the clinical indications for a roentgenologic examination of the small intestine.

Lantern slides of roentgenograms and of colored photographs of the pathologic material will be presented.

**COURSE: 312**

Room: F

Period: Th-2

**A. O. HAMPTON, M.D., Washington, D. C.**

**The Roentgenologic Diagnosis of Pulmonary Infarction; Technique and Interpretation of Venograms and their Importance in Prevention of Fatal Pulmonary Embolism**

This discussion will include:

1. The appearance of bronchial occlusion in the lateral view of the chest.
2. The roentgen diagnosis of pulmonary infarction with special reference to the indications for venograms.
3. A few remarks on the technique and interpretation of venograms.
4. The importance of the roentgen examination of the chest and deep veins of the legs in the prevention of fatal pulmonary embolism.

**COURSE: 313**

Room: D

Period: W-2

**HUGH F. HARE, M.D., Boston, Mass.**

**Myelography**

Myelography may be useful when performed with either oxygen, iodized oil (lipiodol) or pantopaque. It may be diagnostic or may be used as an aid to diagnosis.

The period will be devoted to a discussion of the various methods of myelography and their relative values in diagnosis.

**COURSE: 314**

Room: A

Period: F-1

**F. J. HODGES, M.D., Ann Arbor, Mich.**

**Nontuberculous Lesions of the Chest**

While it is frequently impossible to eliminate pulmonary tuberculosis as the cause of abnormal roentgenologic findings in chest films, a considerable number of intrathoracic conditions can be differentiated with considerable certainty in their own right. Even though a positive pathological diagnosis cannot be made in every instance, careful analysis of roentgenograms can provide diagnostic information of great value. Some outstanding examples of nontuberculous lesions which do present recognizable roentgenologic signs will be demonstrated and the steps leading to accurate diagnosis will be discussed.

**COURSE: 315**

Room: A

Period: T-2

**A. S. MACMILLAN, M.D., Boston, Mass.**

**Roentgen Examination of the Accessory  
Nasal Sinuses**

The technique of examination of the patient for suspected sinus disease will be considered. Particular stress will be placed upon four positions which the instructor considers the irreducible minimum in the examination of the sinuses.

Acute and chronic sinusitis, the sinus involvement in allergy and in malignant disease as well as the cause of exophthalmus in sinus involvement.

There is a great deal of discussion among otolaryngologists as to the value of the roentgen ray as an aid in the diagnosis. An attempt will be made to talk about the practical points in interpretation.

**COURSE: 316**

Room: E

Period: W-2

**A. S. MACMILLAN, M.D., Boston, Mass.****Roentgen Examination of the Mastoids**

The technique of the examination of the patient for mastoid involvement in acute infections of the middle ear will be considered. Demonstrations of the various positions for the examination of the petrous pyramid in the search for involvement of this area as a complication of infection and invasions by new growths of the base of the skull and nasopharynx.

He will consider the rôle played by the roentgen ray in the determining of the optimum time for operation, the limitations of this type of examination.

**COURSE: 317**

Room: F

Period: T-1

**CARLETON B. PEIRCE, M.D.,  
Montreal, Canada****Bronchographic Technique with Demonstration of  
the Anatomy and Pathologic Changes of  
the Bronchial Tree**

The preparation of the patient for bronchography, the apparatus used and the various techniques for instillation of iodized oils will be demonstrated and discussed briefly.

Major emphasis will be placed on the demonstration of the topography of the normal bronchial tree, the localization and diagnosis of pathologic changes of the trachea and bronchi.

**COURSE: 318**

Room: D

Period: Th-2

**L. R. SANTE, M.D., St. Louis, Mo.****The Pneumonias; With Special Reference to the  
Relationship of Virus Infection and Tumor  
Formation**

Pneumonias of the virus type attack primarily the five fundamental structures of the lung: alveolar structure, bronchi and peribronchial tissue, vascular structure, lymphatics, and interstitial tissue of the lung. Atypical pneumonias, regardless of the cause, all seem to have the site of predilection in the interstitial tissue. Certain observations are suggestive of the relationship of virus infection to lung tumor formation.

**COURSE: 319**

Room: E

Period: F-1

**RICHARD SCHATZKI, M.D., Boston, Mass.****Small Bowel Enema**

1. Technique of examining the small intestine with the help of the small bowel enema will be described.

2. Indications and contraindications will be discussed.

3. The method will be compared with other methods of examining the small bowel.

4. Practical examples will illustrate the discussion.

**COURSE: 320**

Room: H

Period: Th-2

**HARRY M. WEBER, M.D., Rochester, Minn.****Chronic Ulcerative Colitis and Allied  
Intestinal Disorders**

The name "chronic ulcerative colitis" may validly be applied to any non-neoplastic pathologic process in the large intestine in which inflammatory changes are predominant. In a restricted sense, however, the name denotes a specific disease entity, the etiology of which is still not established with certainty, but which has distinctive pathologic features. These characteristic pathologic characteristics are observed directly at proctosigmoidoscopic examination, and are reflected in the roentgenologic changes observed with the disease. These roentgenologic manifestations will be described and correlated with those of other etiologic types or more or less diffuse inflammatory processes commonly encountered in the colon. Emphasis will be on roentgenologic aspects, but the proctosigmoidoscopic manifestations will be demonstrated with a motion picture in color prepared by Dr. L. A. Buie and his associates in the Section on Proctology, Mayo Clinic.

**COURSE: 321**

Room: B

Period: T-1

**BARTON R. YOUNG, M.D., Philadelphia, Pa.****Roentgen Diagnosis of Diseases of the Air and  
Food Passages of the Neck; Planigraphy of  
the Larynx**

The normal roentgen anatomy of the soft tissues of the air and food passages is reviewed in detail in the first part of the course. Roentgenoscopy is an indispensable preliminary procedure, so considerable time is devoted to a discussion of this part of the examination. The disturbances in deglutition due to tumor, infection or faulty innervation and the altered physiology and morphology of the larynx that result from



any one of these conditions are readily detected by roentgenoscopic examination, and the roentgenoscopic appearances of some of the more common lesions are shown.

The changes in the air and food passages produced by foreign bodies and inflammatory and neoplastic diseases are demonstrated by exhibiting non-planigraphic and planigraphic roentgenograms. A technique for obtaining posteroanterior studies using non-planigraphic methods is outlined, and the value

of this procedure for lateralizing laryngeal lesions is emphasized by showing illustrative cases.

The indications for body section roentgenography, and the results obtained from the application to the neck are presented. Planigraphy is of maximum value in the demonstration of tumors of the larynx but its superiority to conventional roentgen methods is not limited to the larynx. The planigraphic appearance of a number of interesting lesions in the larynx and cervical trachea is shown and discussed.



## Section on Instruction

### ORDER SHEET

It is important to register for the Instruction Courses as early as possible since the number admitted to each course will be limited. *It is also very important that you list your first, second and third choice for each period.* All orders for tickets will be filled according to postmark on envelope.

Non-members, except full time graduate students in Radiology, will pay \$1.00 for each course-period or a maximum of \$5.00 for five or more such periods. *Non-members' fees must accompany this order sheet* and will not be returned unless cancellation is received before September 13, 1947.

Fill out the following (type or print):

.....	.....	Check {	<input type="checkbox"/> Member
Last Name	First Name or Initials		<input type="checkbox"/> Guest
.....	.....		<input type="checkbox"/> Graduate Student
.....			in Radiology at:
Street Address			
.....			
.....	.....		
City	State		

For convenience in selecting your courses, consult the condensed schedule on the following pages.

### CLAIMING INSTRUCTION COURSE TICKETS

Beginning Monday, September 15, those who have sent in advance orders may secure their tickets at the Registration Desk. Tickets may also be secured for courses not filled.

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Please remember that the Sequential Courses are continuous courses and run from two to four periods. *No part of them is repeated.* They are numbered A to F. All other courses are single-period courses.

**BE SURE TO FILL OUT SECOND AND THIRD CHOICES FOR EACH PERIOD**

Period	First Choice		Second Choice		Third Choice	
	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Tuesday	1					
	2					
Wednesday	1					
	2					
Thursday	1					
	2					
Friday	1					

Previous to September 6, 1947, send this order sheet to:

B. R. KIRKLIN, M.D., Mayo Clinic, Rochester, Minnesota.

After September 6, 1947, mail to:

B. R. KIRKLIN, M.D., American Roentgen Ray Society, Haddon Hall, Atlantic City, New Jersey.

## CONDENSED SCHEDULE OF COURSES ON TUESDAY

Code: T-1

1st PERIOD—2:00 to 3:15

Code: T-1

C—Golden	Roentgenology of the Small Intestine	207—Leucutia	Radiation Therapy in Tumor of Bone
E—Wasson	Anatomy of the Lungs	308—Doub	The Intervertebral Disc
F—Wyatt Randall	Benign and Malignant Lesions of Bone	317—Peirce	Bronchographic Demonstration of Anatomy and Pathology of Bronchial Tree
101—Braestrup	Common Causes of Radiation Hazards in Roentgenology	321—Young	Diagnoses of Diseases of the Air and Food Passages of Neck. Planigraphy of the Larynx

Code: T-2

2nd PERIOD—3:30 to 4:45

Code: T-2

D—Grier	Diagnosis of Congenital Heart Lesions in Children	302—Bogart	Leukosarcoma
103—Henny	Roentgen-Ray Film Characteristics and Calibration of Apparatus and Processing Solutions	306—Christie	Diagnosis and Treatment of Bronchiectosis
202—Bowling	Diagnosis and Radiation Treatment of Cancer of Uterus	311—Good	The Small Intestine
212—Taft	Dosage Measurement from a Clinical Standpoint	315—Macmillan	Roentgen Examination of Accessory Nasal Sinuses

## CONDENSED SCHEDULE OF COURSES ON WEDNESDAY

Code: W-1

1st PERIOD—2:00 to 3:15

Code: W-1

C—Golden	Roentgenology of the Small Intestine	204—Jacox	Complications following Irradiation of the Pelvis
E—Wasson	Physiology and Mechanics of the Chest and Lungs	213—Widmann	Radiation Therapy in Cancer of the Skin
F—Wyatt Randall	Benign and Malignant Lesions of Bone	301—Bishop	Lesions of the Temporomandibular Joint
102—Failla	Dosage Problems in the Use of Radioactive Isotopes	310—Farrell	Roentgen Diagnosis of Lesions of the Esophagus

Code: W-2

2nd PERIOD—3:30 to 4:45

Code: W-2

A—Bromer	Differential Diagnosis of Skeletal Changes in Diseases of Children	208—Martin	Radiation Treatment of Cancer of the Lip and Mouth
D—Grier	Diagnosis of Congenital Heart Lesions in Children	303—Case	Roentgenologic Diagnosis of Cancer of the Colon
106—Weatherwax	Dosage Calculations in Roentgen Therapy	313—Hare	Myelography
205—Kerr	Irradiation of Malignant Tumors of the Pelvis	316—Macmillan	Roentgen Examination of the Mastoids

## CONDENSED SCHEDULE OF COURSES ON THURSDAY

Code: Th-1

1st PERIOD—2:00 to 3:15

Code: Th-1

C—Golden	Roentgenology of the Small Intestine	209—Newcomet	Radium Treatment of Hemangiomas
E—Wasson	Classification of Diseases of the Lungs	304—Childe	The Normal Encephalogram and Ventriculogram
105—Taylor	Ionization Chambers and their Uses	307—Cole	Problems in Interpretation of Roentgenograms of Chest, Correlated with Pathological Data
201—Ernst	Radiation Treatment of Cancer of the Cervix	309—Fariñas	Bronchography

Code: Th-2

2nd PERIOD—3:30 to 4:45

Code: Th-2

A—Bromer	Differential Diagnosis of Skeletal Changes in Diseases of Children	210—Pfahler	Radiation Treatment of Cancer of the Breast
B—Donaldson	Radiologic Jurisprudence	312—Hampton	Roentgen Diagnosis of Pulmonary Infarction; Venograms
105—Quimby	Dosage Calculation in Radium Therapy	318—Sante	The Pneumonias
206—Lenz	Roentgen Therapy of Lymphosarcoma	320—Weber	Chronic Ulcerative Colitis and Allied Intestinal Disorders

## CONDENSED SCHEDULE OF COURSES ON FRIDAY

Code: F-1

1st PERIOD—2:00 to 3:15

Code: F-1

B—Donaldson	Radiologic Jurisprudence	211—Richards	Radiation Therapy of Malignant Tumors of Lips, Tongue and Mouth
E—Wasson	Roentgenologic Diagnosis of Diseases of the Lungs	305—Childe	Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions
107—Williams	Roentgen-Ray Circuits and Apparatus	314—Hodges	Nontuberculous Lesions of the Chest
203—Friedman	Supervoltage Roentgen Therapy	319—Schatzki	Small Bowel Enema

## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

### AN IMPROVED TECHNIQUE FOR THE ROENTGEN DEMONSTRATION OF THE SEMILUNAR CARTILAGES OF THE KNEE

By JOSEPH C. WEISMAN, M.D.

Kew Gardens, New York

**D**URING World War II, military roentgenologists must have been impressed by the great number of requests for roentgen diagnosis of the knee with the notation "internal derangement." They must have had a sense of misgiving in submitting a report of "negative" or "no bone pathology" knowing that visualization of the semilunar cartilages would often have demonstrated pathological changes in the knees. An interesting bibliography is accumulating in the literature on methods of demonstrating these important structures and the criteria for differentiating normal and abnormal findings. Some<sup>1</sup> have recommended traction of the leg by two assistants with the production of a vacuum in the knee joint. This method in my experience is uncertain of results, uncomfortable to the patient, exposes the assistants to unnecessary secondary radiation and often produces blurred roentgenograms. The injection of a radiopaque fluid has also been advocated. This is a rather formidable procedure for diagnosis and the diagnostician would often be deterred from advising it. The soft tissue technique<sup>2</sup> would be ideal if it produced uniform results when used by the average roentgenologist. The personal equation often enters in interpreting soft tissue detail. The air injection technique is a quick and harmless office procedure and was excellently described by Grossman and Minor.<sup>3</sup> The technique to be described is an improvement in that it is simpler, results in better roentgenograms and does not require an assistant.

The apparatus required is merely a padded L-shaped 2 by 4, the vertical por-

tion being about 6 inches high; the horizontal portion long enough so that the knee to be examined is in the center of the table when in position. Two long 20 penny nails are driven into the lateral end of the L-shaped 2 by 4, so that they fit into the slotted side rail of the table. Two strong cloth loops which fit above and below the knee and two large safety pins complete the equipment.



FIG. 1. Patient in position with loops producing abduction for anteroposterior view of the right medial semilunar cartilage.



FIG. 2. Close-up view showing construction of L-shaped 2 by 4 and cloth loops.

With the patient seated on the roentgenographic table about 20 cc. of air filtered through sterile gauze is injected into the knee joint from a point just lateral to the infrapatellar ligament. The skin is of course first surgically cleansed. Preliminary procaine infiltration is unnecessary if the operator is firm and deliberate. The patient is now placed supine on the table; the

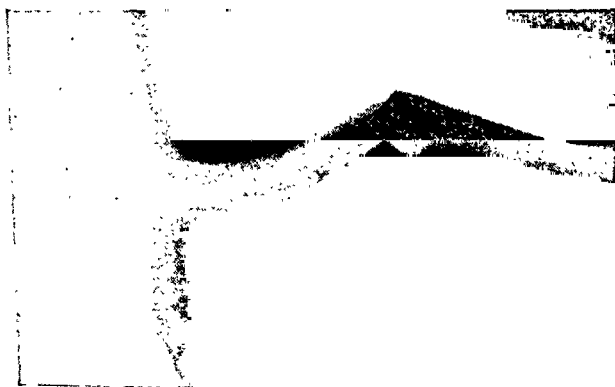


FIG. 3. Posteroanterior view of the lateral cartilage and lateral collateral ligament.



FIG. 4. Posteroanterior view of the medial cartilage showing slight tear at junction of outer edge of cartilage and medial collateral ligament.

knee joint to be examined against the padded vertical upright. The upper cloth loop is slipped on to a point above the knee joint; the lower loop below the knee joint. The trailing ends of the loops are threaded through the slotted edge of the table and fixed in position with safety pins, comfortable abduction being maintained by the lower loop. An anteroposterior view of the knee using the standard technique will give constant and excellent visualization of the medial cartilage. In order to visualize the lateral cartilage, the patient is reversed on the table, the tension of the lower loop now producing adduction.

The accompanying photographs will more readily illustrate the above description. Both anteroposterior and posteroanterior views of each cartilage should be taken before a pathological condition can be ruled out.

109 80th Road  
Kew Gardens, N. Y.

#### REFERENCES

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### ABDOMEN

SCHINDLER, RUDOLF, BLOMQUIST, OLOV A., THOMPSON, HAROLD L., and PETTLER, ARTHUR M. Leiomyosarcoma of the stomach—its roentgenologic and gastroscopic diagnosis and its possible relation to pernicious anemia. *Surg., Gynec. & Obst.*, March, 1946, 82, 239-252.

Leiomyosarcoma is one of the rarest tumors of the stomach. Because the authors have observed 4 cases within a relatively short period of time, they feel that this tumor may not be so rare as has been previously reported.

The diagnosis of this tumor is important because of its good surgical prognosis. The surgeon who may be inclined not to operate on large infiltrative carcinomas, must, nevertheless, consider the presence of a leiomyosarcoma which has a favorable prognosis, and should not refuse to give the patient a chance as long as this tumor cannot be excluded.

The authors have collected a total of 94 cases of gastric leiomyosarcoma from the literature.

*Pathology.* The differentiation of leiomyosarcoma from benign leiomyoma is not easy.

Benign myoma of the stomach occurs frequently. These submucosal tumors are usually small and sharply circumscribed.

Frequently, malignant leiomyomas will not form metastases for a long period of time, but they quickly break their natural boundaries, grow expansively and partly infiltratively and prove to be fatal. The infiltration never reaches the degree found in infiltrative carcinoma, and frequently a limiting capsule is still present. Most leiomyosarcomas are probably malignant from the beginning on.

There are several gross forms of leiomyosarcoma: (1) they may grow into the lumen of the stomach and may then even become pedunculated; (2) they may expand within the gastric wall; or (3) they may expand into the omentum or neighboring structure. Ulceration of the mucosa covering the tumor is frequent in all forms.

The differential diagnosis between leiomyosarcoma and lymphosarcoma is particularly

important, because the lymphosarcoma reacts so well to roentgen therapy while the leiomyosarcoma requires surgical treatment. The lymphosarcoma usually infiltrates the entire wall of the stomach, diffusely involving the entire organ although sometimes solid circumscribed tumors may occur. The leiomyosarcoma grows more expansively, but less infiltratively.

The differentiation between leiomyosarcoma and carcinoma is more difficult. It has been said that on palpation, the leiomyosarcoma has a rubbery consistency as contrasted to the stony hard palpatory sensation caused by carcinoma yet the gross differential diagnosis may be impossible.

Metastases were found in 15 per cent of the leiomyosarcomas collected by the authors.

*Clinical Findings.* The three cardinal findings are: (1) gastrointestinal hemorrhage leading to anemia; (2) epigastric or left upper quadrant pain; (3) upper abdominal mass.

*Roentgenologic Findings.* In 3 of the authors' 4 cases the roentgenologic diagnosis of a submucosal tumor would not have been entirely impossible. It must be admitted that in some cases the differentiation from carcinoma by roentgen rays is impossible but the roentgenologic syndrome of filling defect plus central niche plus fistulas should be considered as highly suggestive of leiomyosarcoma.

*Gastroscopic Diagnosis.* In none of the 4 cases was the correct diagnosis made at gastroscopy but, in retrospect, the authors believe that the correct gastroscopic diagnosis should have been made in every case. The key findings include: "soft, protruding mass," "bridging folds," "toward the upper edge of the wall several mucosal folds converged, one of them running up to the wall in a manner usually seen only in submucosal tumors."

*Relationship between Leiomyosarcoma and Pernicious Anemia.* The frequency of benign adenomas in pernicious anemia is well known. More and more the opinion gains ground that carcinoma develops secondarily to pernicious anemia more frequently than should be expected. However, no such relationship is known between pernicious anemia and tumors of muscular tissue.

In 1 of the authors' 4 cases of leiomyosarcoma, a pernicious anemia picture was present. Although the possibility of a macrocytic anemia being caused by the leiomyosarcoma in this case cannot be definitely excluded, the possibility of the reverse sequence is suggested, namely, pernicious anemia leading to the formation of leiomyosarcoma.

*Treatment.* Roentgen therapy of gastric leiomyosarcoma is ineffective. Surgery is eminently satisfactory. In leiomyosarcoma the surgeon cannot be too courageous. The excellent results obtained in this series of 4 cases justifies the attempt to remove even the largest tumors. Three patients survived extensive operative procedures and seem to be cured permanently. One patient died postoperatively not from any abdominal catastrophe but from a massive pulmonary atelectasis.—*Mary Frances Vastine.*

HICKEN, N. FREDERICK, and CORAY, Q. B.  
Spontaneous gastrointestinal biliary fistulas.  
*Surg., Gynec., & Obst.*, June, 1946, 82, 723-730.

Contrary to accepted opinions, spontaneous gastrointestinal biliary fistulas are not medical curiosities. Kehr encountered 100 such fistulas during the routine performance of 2,000 cholecystectomies. Pjestow found that 3.5 per cent of all patients having operation on the biliary tract had these troublesome complications. The 15 cases forming the basis of this report represent an incidence of 4.2 per cent. Therefore, 1 of every 25 patients requiring surgical therapy for disorders of the biliary tract will possess some variety of internal biliary fistula.

#### *Summary.*

1. Gallstones, peptic ulcers, new-growths and surgical trauma were the etiological agents in 272 cases studied (15 were personal cases of the authors).

2. A preoperative diagnosis of gastrointestinal biliary fistulas cannot be made from clinical findings alone. Careful roentgenographic diagnosis affords the only method of making an accurate preoperative diagnosis. The roentgenographic demonstration of ingested barium or gas, or both, in any segment of the biliary tract is presumptive evidence of a fistulous communication with the gastrointestinal tract.

3. Cholangiograms, performed on the operating table, afford an excellent method of visualizing the gall bladder, fistulous tract, and entire biliary tree. Cholangiograms determine

the location and ramifications of the fistula and clearly depict the size of its orifices. Cholangiograms permit accurate localization and differentiation of existing choledochal obstructions, whether caused by stones, strictures, pancreatitis, carcinoma, ulcers or periductal inflammation. Such visualizing roentgenograms provide the surgeon with an accurate blueprint of problems confronting him.—*Mary Frances Vastine.*

BARBOSA, JORGE J. deC., DOCKERTY, MALCOLM B., and WAUGH, JOHN M. Pancreatic heterotopia; review of the literature and report of 41 authenticated surgical cases, of which 25 were clinically significant. *Surg., Gynec. & Obst.*, May, 1946, 82, 527-542.

There are approximately 470 recorded cases of pancreatic heterotopia. Pancreatic heterotopia is observed fairly frequently at routine necropsies. The authors found an incidence of one case of pancreatic heterotopia in approximately every 500 operations in the upper abdominal region. The incidence of pancreatic heterotopia is highest in the fourth, fifth, and sixth decades of life.

The ratio of males to females is almost 3 to 1. The most common location is in the stomach, duodenum, and jejunum, where the incidence is almost 70 per cent. In the majority of the cases the mass of heterotopic pancreatic tissue is single and its diameter usually varies from 1 to 4 cm.

The histopathologic picture of heterotopic pancreatic tissue is frequently the same as that of the pancreas itself. The commonest histologic location of heterotopic pancreatic tissue in this series was the submucosa alone. Frequently, there is intermuscular infiltration. In the vast majority of the cases there is histologic evidence of acinar function. There is no apparent change in the results of analysis of gastric contents associated with a pancreatic heterotopia.

Hypoglycemia and hyperinsulinism have been observed in association with heterotopic pancreatic tissue presenting both benign and malignant change in its insular portion. If exploration is being carried out in a case of hypoglycemia with definite "Whipple's essential triad" and, after a thorough search, no tumor is found in the pancreas, the surgeon should search for heterotopic pancreatic tissue in its most common locations and also in the unusual sites that are capable of exploration.

Both adenomas and adenocarcinomas of islet cell type may be present without clinical evidence of hypoglycemia.

Heterotopic pancreatic tissue presents the same pathologic changes as the pancreas itself. In many cases the ducts are found dilated. Malignant change is more likely to take place in heterotopic pancreatic tissue than in the pancreas proper. Pancreatic heterotopia may be the cause of several types of pathologic changes in the adjacent tissues; namely, fat necrosis, inflammation, ulceration, hemorrhage, necrosis, and formation of a diverticulum.

In a high percentage of surgical cases of pancreatic heterotopia (61 per cent of the authors' cases) the heterotopia is found to be of clinical significance. The location is usually gastric or duodenal. Some of the rare adenocarcinomas of the duodenum may have had their origin in heterotopic pancreatic tissue either in the ampulla of Vater or in the papilla of Santorini. The syndromes presented by a pancreatic heterotopia are generally those of gastric or duodenal ulceration, cholecystic disease, or indeterminate digestive symptoms.

The pathologic diagnosis with frozen section technique at the time of operation is of inestimable value. A mass of heterotopic pancreatic tissue can be mistaken for a malignant growth both roentgenologically and at operation with a consequent unnecessary operation. When the pancreatic heterotopia is clinically significant, its simple excision when feasible is entirely sufficient for complete relief of symptoms. When found incidentally at operation, the removal is indicated in the majority of cases.—*Mary Frances Vastine.*

DICKSON, JAMES A., PARKHILL, EDITH M., and KIERNAN, PAUL C. Large retroperitoneal metastasis from a so called carcinoid of the small intestine. *Surg., Gynec. & Obst.*, June, 1946, 82, 675-681.

Carcinomas of the small intestine are comparatively rare, comprising about 3 per cent of all intestinal cancers. The so-called carcinoid tumors constitute approximately one-fourth of all malignant neoplasms of the small bowel. These tumors have also been termed argentaffinomas, chromaffinomas, paragangliomas, and primary carcinomas. They occur at least two times more frequently in the appendix than in the small bowel. However, this type of neoplasm has been known to occur in all locations

of the gastrointestinal tract from cardia to anus. In the small intestine carcinoid tumors are characterized particularly by occurring in older persons and by the multiplicity of their primary lesions in contrast to the single primary lesions occurring in the appendix, which are seen most frequently in younger persons.

The present report is concerned with a single small primary growth in the ileum with extension into the mesentery and a large retroperitoneal metastasis of both surgical and pathologic interest.

*Origin of the So-Called Carcinoid Tumors.* The exact cells of origin of these tumors have not been conclusively demonstrated and authorities are not agreed. The weight of evidence seems to be in favor of their origin from the argentaffin cells found distributed irregularly in the gastrointestinal tract and notably within the crypts of Lieberkühn.

*Pathologic Aspects of So-Called Carcinoid Tumors of the Small Bowel.* The primary tumors are characteristically small in contrast to the much larger metastatic foci. They are characteristically yellow and frequently one may suspect the diagnosis grossly after sectioning the lesions. Frequently the lesions extend into the intestinal mucosa and lumen of the bowel. Their growth in the intestinal wall results in kinking or angulation of the involved segments. Gross ulceration of mucosa may be absent, a fact that explains the absence of intestinal bleeding in many of these cases.

These neoplasms are carcinomas and are characterized by slow growth. Burckhardt remarked that "Metastasis from carcinoids is merely a matter of time."

*Clinical Aspects.* Symptoms, when present, are usually those of a chronic intestinal obstruction resulting from kinking of the involved segments of the bowel. Intussusception of the bowel may occur. The patient is usually not very ill and loss of weight is usually not pronounced.

Roentgenographically, one may be able to demonstrate slight kinking and angulations of the involved portions of intestine associated with a small tumor projecting into the intestinal lumen. The kinking and the tumor may be the only signs demonstrable.

*Surgical Aspects.* The ideal surgical management for carcinomas of the carcinoid type involving the small bowel is resection of the segments of bowel containing the small, single or multiple primary lesions with removal of all

metastatic foci when feasible, including the involved lymph nodes.—*Mary Frances Vastine.*

BABCOCK, WAYNE W. Lumbar appendicitis and lumbar appendectomy. *Surg., Gynec. & Obst.*, April, 1946, 82, 414-416.

A type of appendicitis is described in which the inflamed organ has a posterior or retrocecal position. The infection spreads through the thin contiguous peritoneal layer with little abdominal reaction and produces a spreading phlegmon or abscess in the poorly resisting loose areolar tissue of the retroperitoneal space in the right lumbar and pelvic areas. As the signs and symptoms are predominantly in the right lumbar region, the author has termed the condition "lumbar appendicitis." The appendicitis tends to subside spontaneously probably largely by discharge of inflammatory products through the open lumen of the appendix into the cecum. It is associated with so few characteristic symptoms as to be overshadowed in the later development of a perinephritic or pelvic abscess. In those cases in which the appendiceal symptoms are more definite, the retroperitoneal extension may be diagnosed and drained through the abdomen as a localized intraperitoneal collection.

*Symptoms and Signs.* The initial symptoms of lumbar appendicitis usually are abdominal colic, nausea and fever, soon followed by pain, tenderness, and muscular rigidity in the loin, but with a degree of fever and possibly a chill unusual in acute appendicitis. This condition is to be attributed to the greater toxic absorption from the peritoneal space than from the peritoneum.

Especially characteristic are symptoms due to the irritation of structures surrounded by the inflamed extraperitoneal connective tissue. These include the right genitofemoral, lateral femoral cutaneous, femoral and obturator nerves, and the ureter.

The syndrome of pain, tenderness, and rigidity in the lower right loin, with pain and tenderness referred to the right testicle and anterior part of the right thigh occurring after a brief abdominal attack, is quite diagnostic.

*Treatment.* In treatment it is important that the appendix be removed and the phlegmon drained through a lumbar or retroperitoneal approach. Otherwise the surgeon may remove an inflamed appendix and overlook the retroperitoneal phlegmon or drain the pelvic or perirenal abscess and overlook the appendix. With

removal of the appendix the peritoneum may be closed or drained with the lumbar-pelvic space through a single lumbar incision.—*Mary Frances Vastine.*

GLOVER, ROBERT P., and WAUGH, JOHN M. The retrograde lymphatic spread of carcinoma of the "rectosigmoid region"; its influence on surgical procedures. *Surg., Gynec. & Obst.*, April, 1946, 82, 434-448.

Moynihan, in 1908 made the significant statement that "the surgery of malignant disease is not the surgery of organs; it is the anatomy of the lymphatic system." Nowhere is this more applicable than to malignant disease of the rectum. It is toward the anatomy of the lymphatic system that the greater portion of this study has been directed. In their conclusion, the authors state, "The following significant features deserve a word of emphasis:

"1. Because carcinoma of the rectum is primarily of a low grade of malignancy, the disease tends to remain localized for a considerable period and thus lends itself admirably to surgical attack.

"2. As carcinoma of the upper part of the rectum and the rectosigmoid has only one normal channel for lymphatic spread—upward—provided local growth by direct extension has not incorporated neighboring organs, it should be suitable for radical segmental resection with preservation of the rectal sphincter and restoration of the normal continuity of the bowel.

"3. Radical segmental resection implies the removal of a wide section of bowel together with its complete node-bearing region just as the abdominal portion of a combined abdominoperineal resection is now performed.

"4. Section of the bowel must be at least 2 centimeters below the lower palpable edge of the lesion to satisfy pathologic requirements. The technical requirements in the successful performance of an adequate anastomosis in this area also involve the removal of such an amount of tissue because of the size and position of neoplasms so located.

"5. It has been demonstrated that even in far advanced cases of carcinoma in this region, retrograde spread along the course of the bowel occurs to any degree in only 1 per cent.

"6. When such retrograde spread can be demonstrated, it is an indication that upward normal channels have been blocked.

"7. When these facts become more generally appreciated and the technical procedures re-

quired for such surgery are subjected to refinement, many sufferers from neoplastic lesions in the rectosigmoid region will enjoy a normal postoperative existence without the psychologic—to say nothing of the anatomic—detriments of a permanent artificial anus.”—*Mary Frances Vastine*.

ALLEN, ARTHUR. Restoration of continuity versus cure in carcinoma of the rectum. Editorial. *Surg., Gynec. & Obst.*, April, 1946, 82, 490.

There is a widespread revival of operations designed to preserve the rectal sphincter in patients with carcinoma of the rectum and rectosigmoid. This aim to preserve the sphincter is a natural outcome of advanced surgical skill and technique, on the one hand, and, on the other, of evidence that primary spread of disease from this region cephalward.

In a recent series of 100 consecutive patients with carcinoma of the rectum and the average duration of disease before entry into the Massachusetts General Hospital was seven months. Twenty-eight had such extensive disease that a resection was impossible. Seventy-two had an abdominoperineal resection in one or two stages. There were 2 deaths in this group, a postoperative mortality of 2.8 per cent. About 10 per cent of the resections were done in the presence of hepatic metastases. Including the operative deaths, approximately 45 per cent of the operable cases or 30 per cent of the entire group will live five more years. It appears at this time that only earlier diagnosis will materially improve these results.

The best, safest, and most adaptable operation so far devised is the combined abdominoperineal resection of Miles. This procedure does leave the patient with a colostomy but colostomy is not burdensome to thousands of grateful individuals who have been cured of cancer. —*Mary Frances Vastine*.

#### GYNECOLOGY AND OBSTETRICS

MONTGOMERY, JOHN B., and LANG, WARREN R. Evaluation of a new contrast medium for hysterosalpingography. *Am. J. Obst. & Gynec.*, May, 1946, 51, 702-705.

Visco-rayopake (diethanolamine salt of 2, 4-dioxo-3-iodo-6 tetrahydropyridine acetic acid) a new opaque medium which was introduced by Rubin in 1941 has been found to be highly satisfactory for roentgen study of the

uterine tubes. The outstanding advantage of this substance is due to the fact that it is well tolerated by the tissues and is rapidly absorbed from the peritoneal cavity. It was used to study the patency of the uterine tubes in 79 patients. In 25 of these, the visco-rayopake flowed freely into the peritoneal cavity where it was absorbed within thirty minutes.

*Technique.* The patients are hospitalized for part of a day and each is given  $1\frac{1}{2}$  grains of seconal or 3 grains of sodium amytal and  $1/150$  grain of atropine sulphate hypodermically one-half hour before the salpingography is done. Following the procedure, they are confined to bed for three or four hours and then they are permitted to leave the hospital.

Careful aseptic technique is observed. The cannula is inserted into the cervical canal after the usual vaginal preparation in the operating room. Under fluoroscopic control, the visco-rayopake is carefully injected with a 20 cc. Luer Lok syringe. The fluoroscopic examination enabled the authors to observe the freedom with which the fluid medium passed from the endometrial cavity into the tubes as well as to determine the most favorable time for making the roentgen exposure. In some instances, the opaque material did not enter the tubes until slightly increased pressure was maintained on the plunger of the syringe for a fairly brief period of time, although usually when the uterine tubes were patent it flowed freely without this temporary delay.

As a rule, 3 or 4 cc. are required to fill the uterine cavity; when the tubes are patent, 10 to 15 cc. are injected. Stereoscopic films are made in the anteroposterior position at the optimum time as indicated by fluoroscopic observation. Films made routinely one-half hour after the injection reveal only very slight amounts remaining in the pelvis and in many cases it has disappeared completely. This rapid absorption of the visco-rayopake from the peritoneal cavity constitutes its most outstanding advantage.

The density of the shadows cast by the visco-rayopake is highly satisfactory under the fluoroscope and also on the roentgenograms. The excellent visualization of the tubes is made possible, of course, by the high viscosity of this fluid medium which causes it to remain in the tubal lumen long enough to permit roentgenograms to be made.

The local discomfort produced by injecting visco-rayopake into the uterus and uterine tubes is not marked. In some instances, sharp

menstrual-like cramps resulted when the uterine cavity was over-distended by too rapid injection. This was relieved immediately by the withdrawal of a small amount of the fluid. Although no accurate notation of the local pain reaction was made at the time each patient was studied, it is the author's impression that most of the patients were aware of some mild discomfort when the contrast medium flowed into the peritoneal cavity. This varied in intensity with the individual patient and usually disappeared within one hour.

Uterosalphingography has been regarded generally as a more accurate test of tubal patency than the carbon dioxide insufflation test. However, it has not been used as a routine procedure in some clinics because of the shortcomings of the available media and especially because of the danger of local tissue damage by the commonly used iodized oils which remain in the tissues for an indefinite period of time. Visco-rayopake has overcome this difficulty.—*Mary Frances Vastine.*

AABERG, MONRAD E. Recurrent placenta previa and the significance of placentography as a diagnostic criterion. *Am. J. Obst. & Gynec.*, April, 1946, 51, 578-580.

With an incidence of placenta previa at the Boston Lying-In Hospital of 1:92, one would expect a reasonable number of such patients to repeat their experiences. However, a search of case histories at this hospital shows that this complication recurred in only 2 patients since 1925. A review of the literature reveals only 10 cases of recurrent placenta previa in successive pregnancies and 1 case in non-successive pregnancies.

In this paper 2 cases of recurrent placenta previa are presented, 1 in non-consecutive pregnancies and the other in consecutive pregnancies. Since placenta previa is chiefly a multiparous complication, multiparity, together with faulty decidua, undoubtedly is the most important etiological factor.

The advent of placentography invaluablely facilitates an early diagnosis of placenta previa. The author feels that a more accurate interpretation of soft tissue films can be made by application of the following criteria:

1. If the placenta cannot be visualized upon the anterior or posterior uterine walls, a diagnosis of complete previa should be made and confirmed by vaginal examination.

2. When the maximum thickness of the

placenta is visualized at or below the equator of the uterus on the anterior uterine wall, it is very likely to be a placenta previa. The likelihood of a complete previa increases proportionately with the distance of the maximum thickness of the placenta below the equator of the uterus.

3. When the placenta is visualized low on the posterior uterine wall, displacing the presenting part 3 cm. or more from the tip of the sacral promontory or from the base of the fifth lumbar vertebra, a diagnosis of placenta previa should be accepted and corroborated by vaginal examination.

Brown and Dippel noted that calculation of the distance between the presenting part and the sacral promontory was a valuable aid in the diagnosis of placenta previa for the posterior wall implantations, but no figure of mensuration was given.

In the author's clinic, soft tissue films are taken on all patients who have experienced vaginal bleeding during the last trimester. An exception is made only in those patients suffering shock from massive vaginal hemorrhage. Often, when the placenta is visualized high in the fundus, routine vaginal examinations are deemed unnecessary. Conversely, when the placenta is perceived below the equator of the uterus or not seen at all, prompt vaginal examination for the corroboration of the diagnosis should ensue (always in an operating room prepared for an immediate section to assure safety.)—*Mary Frances Vastine.*

#### GENITOURINARY SYSTEM

ANDERSON, LEO, and McDONALD, JOHN R. The origin, frequency, and significance of microscopic calculi in the kidney. *Surg., Gynec. & Obst.*, March, 1946, 82, 275-282.

A study was made of microscopic calculi as found in the pyramids of 168 kidneys. These included surgically removed kidneys and grossly normal kidneys removed at necropsy. The diseased kidneys were removed for tuberculosis, hydronephrosis, pyelonephritis or stones.

The microscopic calculi were found in all of the kidneys. It was demonstrated that they were formed by the coalescing of numerous "droplets" of calcareous material. These droplets seemed to be formed by the process of phagocytic ingestion of tiny "flecks" of black-staining material. Attention was directed to the postulate that the concentration of calcium

is probably high in the tissue fluid about the renal tubules and to the fact that phagocytic cells occur in abundance about the renal tubules. From these data it was suggested that the calculi were formed by the process of phagocytic ingestion of the calcium which is reabsorbed by the renal tubules.

It was shown that the tiny calculi occur throughout the renal parenchyma. Some were located just under the epithelium at the tip of the papilla and one photomicrograph demonstrated the plaque ulcerating through this epithelium and becoming exposed to the urine of the calices. It is now fairly well accepted that some renal calculi are formed by the process of the salts of the urine being deposited in layers on these plaques. Since a chemically pure calculus is very rare, the suggestion is made that perhaps many different types of stone may have this tiny calculus as a nidus.

Since these microscopic calculi occur in practically all people, even though only 1/3,333 part of the total pyramidal region of each kidney was cut and examined, the question was raised as to why then do not more people form symptomatic stones. The interpretation was suggested that large stones may form only when some inciting factor comes to the kidney which causes the salts to deposit on this eroded nidus plaque. Perhaps this inciting factor, substance or catalyst, the absence or presence of which is necessary to cause deposition to occur, comes from outside the kidney. From the foregoing data the proposal was made that perhaps renal calculus is a systemic or a dietary disease and not a disease of the kidney per se.—*Mary Frances Vastine*.

QUATTLEBAUM, FRANK W., DOCKERTY, MALCOLM B., and MAYO, CHARLES W. Adenocarcinoma, cylindroma type, of the parotid gland; clinical and pathologic study of 21 cases. *Surg., Gynec. & Obst.*, March, 1946, 82, 342-347.

Ten per cent of a series of consecutive primary parotid neoplasms appeared to be adenocarcinomas of the type cylindroma, so classified because of a distinctive microscopic pattern.

This group of 21 cases was characterized clinically by the presence of sharp radiating pain and local fixation of tumor in 40 per cent, features unusual in connection with other primary neoplasms of this location. Partial or complete paralysis of the facial nerve was also a contrastingly common finding.

Surgically, the tumors were generally more infiltrative than encapsulated and application of the principle of "wide local excision" prevented recurrences in 5 of 21 cases.

Pathologically, the appearance of dark-staining epithelial islands and strands with central honeycombing in a hyaline stroma was diagnostic. Epithelial mucus was sometimes present. Infiltrative tendencies were pronounced with a special predilection for invasion of nerve sheaths.

Eight of the 20 traced patients succumbed within five years to the effects of metastasis, 5 with evidence of pulmonary spread. Two died more than five years after operation. Four of the remaining 10 are suffering from inoperable (?) recurrences.

Solid tumors of the parotid gland should be assumed to be malignant until proved otherwise.

It is suggested that more radical surgical procedures will have to be done in order to obtain better results in the treatment of this form of neoplasm.—*Mary Frances Vastine*.

GREENE, LAURENCE F., and FERRIS, EDWARD O. Urinary incontinence due to bilateral ectopic ureters. *Surg., Gynec. & Obst.*, June, 1946, 82, 712-716.

Urinary incontinence due to an ectopic ureteral orifice is not common. Most of the reported cases are unilateral.

The ectopic ureter is usually associated with complete duplication of the pelvis and ureter. In most instances the opening of the ureter which leads from the upper segment of the duplicated kidney is ectopic. Rarely the ureter from the lower segment is ectopic or an ectopic ureter may occur with a kidney which is not duplicated.

In cases of bilateral ureteral ectopia the orifices of the ectopic ureters are most frequently situated in the urethra or the vestibule of the vagina. Less frequently one or both ureters enter the prostatic urethra, vas deferens, ejaculatory duct, uterus, or vagina.

*Incidence and Symptomatology.* The condition occurs with much greater frequency among women than among men and the outstanding symptom among women is urinary incontinence. In practically all cases the incontinence is congenital, diurnal and nocturnal and is associated with normal voidings. Among men incontinence is usually absent and the condition is discovered following investigation to deter-



mine the source of infection of the urinary tract.

**Diagnosis.** Excretory urography is valuable in the diagnosis of this condition. In most instances bilateral complete duplication of the renal pelves and ureters will be found. However, those segments of the kidney drained by the ectopic ureters (usually the upper) will be visualized faintly, or not at all, because their function is insufficient to concentrate the contrast medium. In such instances the diagnosis of bilateral complete duplication must be inferred from the fact that the visualized pelves (usually the lower) appear to drain only the lower portion of each kidney. Thus, if by excretory urography and retrograde pyelography a diagnosis of bilateral complete duplication of the pelvis and ureter is made and if but one ureteral orifice is situated at each extremity of the trigone, a diagnosis of bilateral ureteral ectopia can be made.

Because of the infrequency of this condition the authors report 2 cases of bilateral ureteral ectopia.—*Mary Frances Vastine.*

#### NERVOUS SYSTEM

HOLLINGSWORTH, R. K. Intrathoracic tumors of the sympathetic nervous system. *Surg., Gynec. & Obst.*, June, 1946, 82, 682-693.

Neoplasms of the sympathetic nervous system are widely distributed, having been reported as occurring in the adrenal (most frequent site), abdominal, cervical, thoracic and pelvic sympathetics, the jejunum, celiac ganglion, mesentery, liver, coccygeal body, uterus, cavity of the nose, skin and subcutaneous tissue, scapular region and carotid body. Their occurrence within the thorax, while not rare, is still unusual enough to warrant their being classified as a curiosity. More often than not, they are symptomless, their discovery being quite accidental.

**Occurrence.** True nerve tumors, new growths consisting of specific nerve tissue elements, may occur in any part of the nervous structure. They may be benign or malignant and while they may differ widely in their structure, behavior and occurrence, yet they are closely related ontogenetically. Both the benign and malignant forms are well illustrated in the sympathetic system. The benign form includes the ganglioneuromas and the chromaffin tumors, in both of which the cells are more or less highly differentiated. The malignant forms are the neurocytomas or neuroblastomas.

Lewis and Geschickter studied 40 neuroblas-

tomas and found that 33 of them were in the medulla of the suprarenal gland or in the sympathetic ganglions adjacent to the medulla.

#### Discussion.

**Symphogonioma.** This is a very malignant tumor found most commonly as a primary growth in one or both adrenals. Its occurrence in the chest is rare. It is extremely cellular, being composed of closely packed lymphoid types of cells. Very little supporting structure is seen. There is a tendency to rosette formation.

**Symphoblastoma.** These differ from the symphogoniomas only in that they represent greater maturity, are somewhat less malignant and usually are found at a somewhat older age. Intrathoracic symphoblastomas are rare, occurring in only 16 of the 63 cases of sympathetic nerve tumors found recorded to date. While the symphoblasts predominate in the overall picture, sympathetic ganglion cells in all degrees of differentiation are encountered in these tumors.

**Ganglioneuroma.** These are mature tumors in which the neurocytic elements have differentiated into ganglion cells rich in plasma. This tumor is not rare in children. Shultz reported 53 cases not in the adrenal gland. Twenty-four were in adults, 21 in children and in 8 the age was not stated. These tumors are usually firm and well encapsulated. Usually they are relatively vascular and present a grayish-white appearance. Microscopically the picture is usually one of rather coarsely arranged fibrous tissue mixed with strands of medullated and non-medullated nerve fibers, the latter predominating as a rule.

**Chromaffin tumors.** Lewis and Geschickter consider these the most common tumors of the sympathetic system. They are exceedingly rare within the thorax. Their most distinguishing feature is their affinity for chrome salts.

**Dumbbell tumors.** Tumors which present both in the chest and in the spinal canal, the so-called dumbbell or hourglass tumors, are of fairly frequent occurrence particularly among the ganglioneuromas. They are found more frequently in children.

**Neurofibromas.** One must not lose sight of the fact that any of the intrathoracic neurogenic tumors may have their origin from the sympathetic nerve tumors; one instinctively thinks only of the immature and mature ganglion cell tumors already described. However, all the neurogenic elements found in the neurofibromas, schwannomas, etc., are derived from



the ganglionic crest. In addition to this, even though the neoplasm may grossly appear to originate from an intercostal nerve, it must be remembered that intercostal nerves are derived partly from the ganglions of the posterior roots, which ganglions arise from the medullary epithelium by way of the neural crest.—*Mary Frances Vastine*.

EVANS, JAMES A. Reflex sympathetic dystrophy. *Surg., Gynec. & Obst.*, Jan., 1946, 82, 36-43.

Reflex sympathetic dystrophy is a most disabling, often extremely painful, malady following minor sprains, ordinary fractures, or, in military or civil life trauma to blood vessels or nerves. The syndrome is characterized only at times by the excruciating, burning pain that has given it the term "causalgia," hence a misnomer. Pain may be moderate, mild, or absent. The true diagnostic features are those disorders initiated by perversions of reflex sympathetic stimulation, namely increased rubor or pallor, sweating, edema, atrophy of skin, and spotty or even cystic atrophy of bone.

*Mechanism of Reflex Sympathetic Dystrophy.* A prolonged bombardment of pain impulses sets up a vicious circle of reflexes spreading through a pool of many neuron connections upward, downward, and even across the spinal cord, and perhaps reaching as high as the thalamus itself. Because of the summation principle of nervous impulses, there is kept alive within such a pool a constant circling of activity across the synapses involved.

*Etiology.* In the past three years, the author has gathered 32 cases of reflex sympathetic dystrophy. The exciting trauma or diseases are as follows: sprain, 9; fracture, 5; thrombophlebitis, 4; poor foot statics, 3; bruise, 2; scalenus syndrome (?), 2; laceration of hand, 1; anterior poliomyelitis (?), 1; plantar wart, 1; gonorrheal arthritis, 1; thalamic syndrome (cerebrovascular accident), 1. In addition there were the complications of fungus infection in 3 and operative interference in 3.

*Pain.* Pain is usually the most prominent feature in reflex sympathetic dystrophy. It may be one of the most excruciating pains that can be experienced. Trigger points are often multiple and pressure on one often spreads a diffuse pain of a burning, peculiar nature up and down the limb. More often, in less severe cases, the pain response stays definitely localized to the trigger point.

*Other Symptoms and Signs.* (1) Rubor—this may be so constant and the foot or hand be so hot that the picture of erythromelalgia is produced; (2) pallor; (3) swelling or sweating or both; (4) atrophy of the skin; (5) atrophy of the bone. The typical bone atrophy is mottled. In advanced cases, it may even be cystic, presumably owing to nutrient artery spasm. Such bone atrophy was described in the roentgenograms of 6 patients in this series. A diffuse osteoporosis resembling that of disuse was noted in 5 cases.

*Diagnosis.* Either cervical or paralumbar sympathetic procaine block comprises a diagnostic therapeutic test. The relief of pain may be almost miraculous but need not be so dramatic as to establish the diagnosis, provided relief of other phenomena is also noted, such as relief of sweating, increased warmth and comfort in a cold member, associated with rise of skin temperature and disappearance of trigger points.

*Treatment.* So far, no direct effective means is at hand to stop the vicious circle within the pool of neuron synapses (Lorento de No's internuncial pool).

The trigger points may be injected. Repeated injections are usually necessary.

The sympathetic pathway may be blocked by procaine. The author has felt it best to resort to sympathectomy in the majority of his treated cases. Posterior root rhizotomy, cordotomy or, for high cervical segment, interruption of the thalamic pathways in the medulla and even resection of the sensory cortex may be necessary in exceptional cases.—*Mary Frances Vastine*.





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## PLANIGRAPHY IN THE DIAGNOSIS OF BRONCHOGENIC CARCINOMA\*

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**B**RONCHOGENIC carcinoma appears to be increasing in frequency both absolutely and in proportion to other types of malignancy. Westermarck,<sup>11</sup> in an analysis of his material from Sweden in 1939, reported that cancer of the stomach occurs 6.5 times as frequently as cancer of the bronchus while in Nystrom's statistics from Sweden in 1911-1912 cancer of the stomach occurred 74.5 times as often as cancer of the lung. In certain clinics in this country cancer of the lung is second only to cancer of the stomach in frequency as a cause of death in older individuals. There is no good explanation for this marked increase in incidence. The increase in life expectancy may have increased the number of cases of bronchogenic carcinoma more than other types of malignancy.

Certain methods of diagnosis have occupied the first place in the recognition of carcinoma of the lung in the living individual. Bronchoscopic examination has been of great value and has the added advantage of providing a means of biopsy. Many surgeons are not well trained in the technique of bronchoscopy and the method has been steadily improved upon. There

is no comparable method by which the absolutely certain diagnosis so desirable to permit exploration of the thorax can be achieved. There are still many cases, however, in which bronchoscopy is accomplished with difficulty. It requires the use of anesthesia, either local or general, which is time-consuming. Good patient cooperation is required and to many individuals it is a frightening procedure. The poor condition of some patients prevents its use entirely.

The bronchi are not always easily examined by endoscopic methods. Particularly is this true of the upper lobe bronchi which are often technically difficult to visualize with the bronchoscope because of their sharp angulation. Certain anatomical variations of the bronchi or marked distortion of the bronchi from extrinsic lesions often prevent a satisfactory examination. While it is agreed that a positive biopsy is extremely important in the presence of a suspected tumor, a negative biopsy by no means excludes a tumor. Therefore, not infrequently, bronchoscopy is disappointing.

Great advances have been made in the

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roentgenological diagnosis of bronchial lesions. The secondary manifestations of bronchial obstruction are well known and in many cases the trained observer can make a diagnosis of the presence and anatomical position of a bronchial mass from the ordinary routine roentgenograms in various positions. When the presence of a bronchial tumor is suspected, either from the history or from the usual chest roentgenogram, fluoroscopic examination should be carried out. This will be useful in determining the position of the lesion, the location of atelectasis if present, and any alteration in the physiology of respiration. Furthermore, the fluoroscopic study affords the best means of determining the positions in which roentgenograms should be made. Films made in both phases of respiration, especially at the extremes of expiration and inspiration, often demonstrate to the best advantage the presence of emphysema or atelectasis. Obstructive emphysema is best demonstrated in the expiratory phase and a shift of the mediastinum toward the opposite side may be present.

The more common manifestations of bronchogenic carcinoma are well known. A mass either in the hilum or less commonly in the periphery, a localized abscess, an infiltrative process either localized or throughout one lung may be present. More important still are the evidences of bronchial obstruction; that is, localized or unilateral emphysema, atelectasis, bronchiectasis, chronic lung inflammation. Westermarck<sup>10,11</sup> has described three stages in the development of bronchial tumors. In the first stage, there is diminished air content in the segment of the lung involved because of diminished intra-alveolar pressure and hyperemia. The second stage results from an increase in size of the bronchial mass producing a check-valve effect and resulting emphysema. The third stage is that of complete obstruction and atelectasis.

In spite of these well known findings resulting from bronchial tumors, the lesion may be present in an atypical form and

may defy recognition. Any method which could actually demonstrate the tumor itself in a high percentage of cases would be extremely useful.

The instillation of iodized oil into the bronchi is a feasible and highly accurate procedure. With the exception of bronchoscopy, it is, no doubt, the most useful method for the delineation of an intra-bronchial tumor. There are certain contraindications to bronchography, however; in some cases these are sufficient to exclude the method entirely. Furthermore the procedure is not without complications and difficulties so that it is not universally applicable.

One hesitates to administer iodized oil where dyspnea is present. Fever and toxicity are important contraindications. Reactions from local anesthesia, a necessary preliminary for bronchography, are rather infrequent, but are distressing when they occur. Occasional reactions from the contrast medium itself have been reported. Severe cough prevents a satisfactory bronchogram since the oil may be forced from the smaller bronchi into the alveoli obscuring the fields where bronchial visualization is important. Many thoracic surgeons object to bronchography in carcinoma of the lung because they feel surgery should be delayed for a period of six weeks or more after the use of iodized oil. Such a period of waiting allows further increase in size of the tumor.

Without contrast medium the bronchi are usually poorly visualized in the ordinary chest roentgenogram. A method of "air bronchography" has been described by some authors<sup>4</sup> and has proved quite successful in certain cases. The detail, however, is rather poor and in this country has not been widely used. The use of the Potter-Bucky diaphragm will assist in delineating the larger bronchi but the results are often unsatisfactory.

For the delineation of the bronchi, without the use of iodized oil, the roentgen method designated by Moore<sup>8</sup> as body section roentgenography, and variously called

planigraphy, tomography and laminagraphy, has been found to be most useful. Its utilization has increased accordingly despite its rather time-consuming, expensive technique. The history, principles, and details of the procedure have already been described repeatedly by various authors<sup>1,5,8</sup> and need not be dealt with in this paper.

Body section roentgenography has been used with considerable success by a number of investigators for the diagnosis of many portions of the body but most especially in pulmonary conditions. Moore<sup>8,9</sup> used it successfully in the diagnosis of lesions in the skull, spine and lungs. McDougall<sup>7</sup> recorded the efficacy of the method in many areas of the body including the bronchial tree system. Lowry and Rigler<sup>6</sup> demonstrated the actual tumor shadow within the bronchus in 7 cases of bronchial adenoma by means of planigraphy. Greineder<sup>4</sup> published a review of his method of use of planigraphy in the diagnosis of bronchogenic carcinoma in which he described the "tumor-core" shadow. Frimann-Dahl<sup>3</sup> published a series of 56 cases of bronchogenic carcinoma in which he demonstrated positive findings in 46 cases by means of planigraphy. He claimed the method was at least as accurate as were other methods of diagnosis while it possessed the advantage of a minimum degree of disturbance to the patient and there were almost no contraindications.

The technique of body section roentgenography is quite simple after a knowledge of the basic principles has been acquired. In our clinic, the equipment permits planigraphic study only in the recumbent position. It is obvious that films in the upright position would prove quite useful in certain cases especially where it is desired to demonstrate fluid levels within cavities. A special planigraphic attachment is used which allows the film holder with Potter-Bucky diaphragm and the roentgen tube to move in opposite directions in one plane around a point of rotation which represents the desired plane of the object. The depth of the layer may be changed by alter-

ing the point of rotation on the moving arm. The roentgen tube rotates so that the central ray always passes through the focal point in the desired plane.

A trial exposure is made usually at about 10 cm. from the table top with the patient in the supine position. Corrections are then made for exposure and positioning. It is our experience that underexposure is one of the commonest errors in technique. Enough exposure should be given to obtain the proper density of the bronchus when compared with the surrounding areas. The movement of the tube is such as to produce fairly thick sections. Films are taken at 8, 10 and 12 cm. from the table top. Two additional films are then made 1 cm. anterior and 1 cm. posterior to the level giving the most information about the lesion. There are then three films available for examination of the abnormality.

The planes in which films are made should parallel that of the involved bronchus as closely as possible. Films taken in a plane which passes in an oblique direction through the bronchus will produce an appearance of an abrupt ending to the shadow of the bronchial lumen thus simulating bronchostenosis. If the films in the next anterior and posterior positions are examined, however, the continuation of the bronchus will be noted and prevent an error in interpretation (Fig. 1 and 5).

In order to obtain parallel plane films it will be necessary, in some cases, to take lateral or oblique views in respect to the patient's body. Our experience has been largely with anteroposterior views so that the value of other projections has not been clearly ascertained.

The demonstration of an actual defect within the bronchus is the most helpful finding in bronchial tumors (Fig. 2). This is seen usually as a smaller tumor mass of greater density projecting into the air-filled bronchial lumen of lesser density. The lesion may project from one bronchial wall into the lumen or it may completely surround the lumen (Fig. 3). There may be an irregular, elongated stenosis of the bronchus

producing a "rat-tail" deformity (Fig. 4). In these cases, atelectasis is a prominent feature.

The demonstration of a peribronchial or extrabronchial mass is of considerable importance particularly in cases wherein there is some difficulty in delineating the intrabronchial lesion itself (Fig. 5). The presence of atelectasis, in addition to the mass, lends supporting evidence in favor of carcinoma even though an obvious intrabronchial mass cannot be seen. The size and

position of the extrabronchial lesion is of considerable help in determining the prognosis and operability of the carcinoma. The mass is due to extension through the bronchial wall into the peribronchial structures or to extensive involvement of the lymph nodes.

The visualization of a clear cut intrabronchial mass is far more common in the benign adenoma or mixed tumor of the bronchus than in carcinoma.<sup>6</sup> In the malignant lesion inflammation, necrosis and

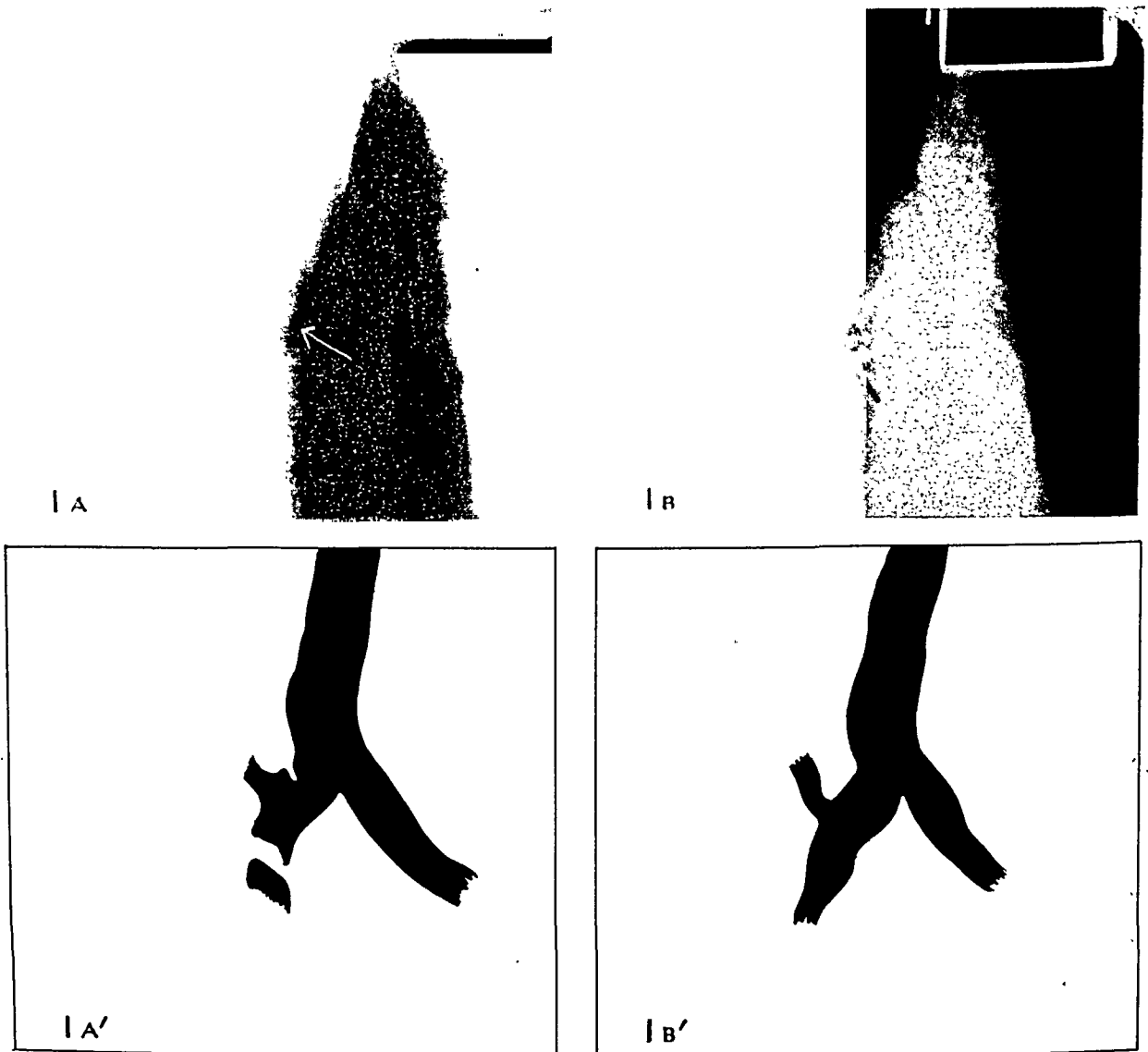


FIG. 1. Planigrams of trachea and bronchi. *A*, section 9 cm. from posterior wall. Note the clear delineation of the trachea, main bronchi and right upper lobe bronchus. The right lower lobe bronchus seems to end in an abrupt triangular shadow (arrow) characteristic of stenosis. *A'*, diagram from a tracing of *A*. *B*, section 10 cm. from posterior wall. The intact lumen of the right lower lobe bronchus is here visible. The enlarged peribronchial lymph nodes caused some angulation producing the appearance of stenosis seen in the more posterior section (*A*). *B'*, diagram from a tracing of *B*.

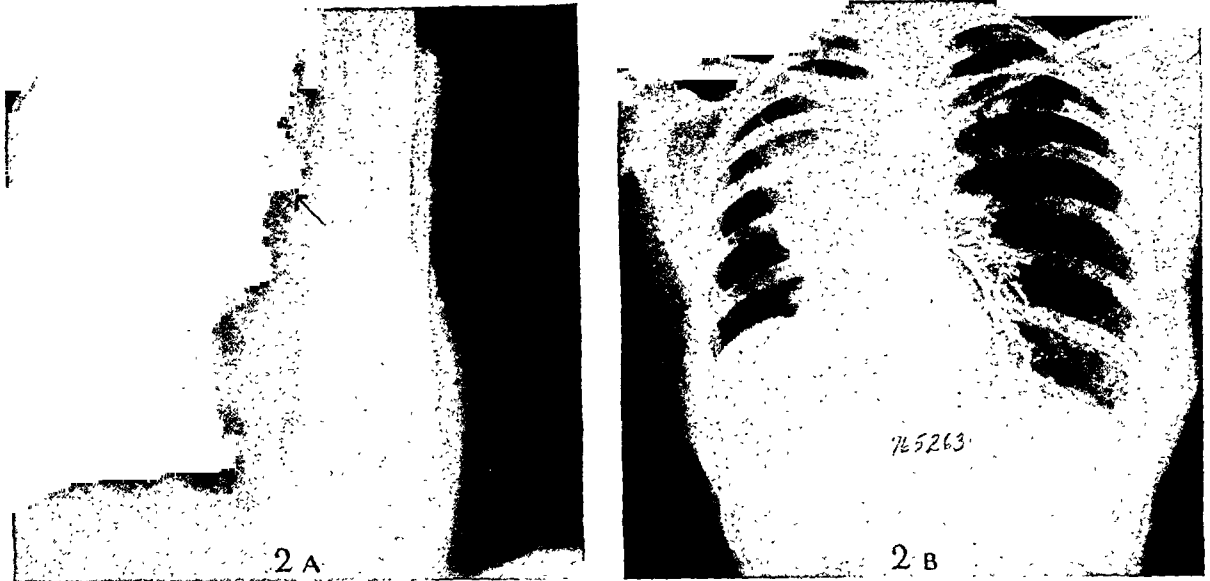


FIG. 2. Carcinoma right upper lobe bronchus. *A*, planigram showing abrupt termination of bronchial airway with a mass of greater density protruding into the bronchial lumen at its end (medial arrow). The peri-bronchial mass is also sharply outlined (lateral arrow). *B*, bronchogram in the same case. Note the striking similarity of the findings. With the iodized oil in the bronchus the tumor produces a defect in the outline rather than a positive shadow as in the planigram.

deep infiltration occur rapidly. As a result there is stenosis of the bronchus so that the air column around the tumor which is so obvious in the benign lesion is lost. There is, therefore, less contrast available in the malignant lesions. The demonstration of a clear column of air almost surrounding the tumor shadow should suggest that the growth may be benign.

On the other hand, the demonstration of a complete or partial stenosis of the bronchus is not sufficient in itself to indicate a diagnosis of carcinoma since inflammatory lesions will also produce narrowing of the bronchial lumen. The distinction between an inflammatory and a neoplastic stenosis is also not easy in the bronchogram. The presence of the typical "rat-tail" deformity or of an irregular elongated narrowing of the bronchus is characteristic. Nevertheless the collateral evidences afforded by the other lung changes, the history and laboratory findings are needed to make sure of the diagnosis if biopsy is not available.

Essentially, planigraphy serves as a supplement to or substitute for bronchography. In many situations an equally good picture of the major bronchi may be obtained by this means (Fig. 2). In some cases

the planigraphic method produces a more graphic demonstration of the tumor itself or of the bronchostenosis than can be obtained by bronchography (Fig. 4).

Just as in bronchography, it is possible by body section roentgenography to demonstrate many of the bronchi so that the presence or absence of other invasion or extension into other bronchi may be observed. An intact lower lobe bronchus in a patient with a carcinoma of the right upper lobe bronchus is illustrated in Figure 3. The contrary is shown in Figure 6 in which the primary lesion in the right upper lobe bronchus as well as an extension in the lower lobe bronchus can be readily seen. For this purpose, also, films in several planes must be examined in order to delineate the various branches (Fig. 7).

Since the introduction of planigraphy in this clinic it has been used on 181 patients suspected of pulmonary disease. In 81 of this series there was no thought of a lung tumor, most of them being cases of tuberculosis or other inflammatory diseases in which it was desired to determine the presence of cavities or other details of the anatomy. One hundred cases were examined because of suspected tumor and in



FIG. 3. Carcinoma of right upper lobe bronchus, planigram. The right main bronchus is well delineated. The upper lobe branch is seen to be completely occluded (upper arrow) by a surrounding mass. The lower lobe bronchus (lower arrow) is clearly outlined and does not appear to be invaded or constricted.

47 of these a bronchial neoplasm was eventually found by one method or an-

other. Several hundred other cases were examined during this period of time for suspected tumor and many more lung tumors than the above 47 were seen. The remaining were not subjected to planigraphic study because the diagnosis was obvious without the need of special procedures, or had been proved by some other procedure, or the patient was too ill to be moved to the roentgen department or for many other reasons. It should be noted that for a period of several years a potent force militating against the use of planigraphy was the severe shortage of roentgen film.

Among the 47 recorded bronchial tumors in which planigraphy was used there were 10 of the so-called bronchial adenoma type, all apparently benign as indicated by their history, course, and histopathologic examination. Seven of these have already been reported.<sup>6</sup> The remaining 37 were bronchial carcinomas as indicated by the collateral findings. In all but 9 of these the diagnosis was proved by microscopic examination of the tissue. In the latter cases the other findings and the course of events were so characteristic as to leave no doubt as to the diagnosis.

The 47 patients with bronchial tumors were submitted to a number of procedures

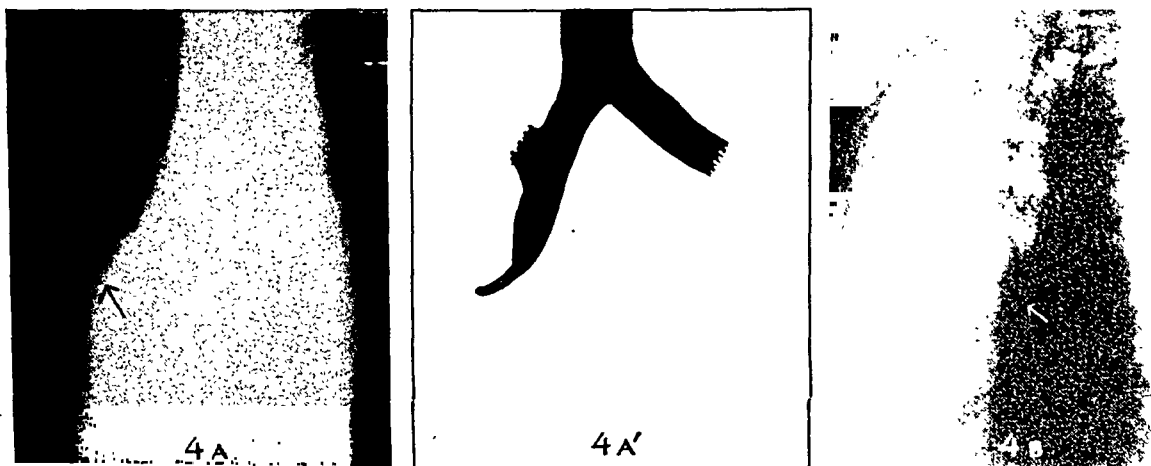


FIG. 4. Carcinoma of right stem bronchus. *A*, planigram showing elongated, irregular stenosis (arrow) with air column extending into the mass. The "rat-tail" appearance is well shown. *A'*, diagram from a tracing of *A*. *B*, bronchogram in the same case. The stenosis of the bronchus is well demonstrated by the iodized oil column (arrow). Note that the air column shown in the planigram (*A*, *A'*) extends to a point distal to the end of the iodized oil column. Thus, occasionally, planigraphy gives a more faithful reproduction of the pathological anatomy than does bronchography. The atelectasis of the middle and lower lobes and the emphysema of the upper lobe are also seen.

TABLE I

	No. of Cases Examined	Successful Demonstration of Tumor	Per Cent	Unsuccessful Demonstration	Per Cent
Planigraphy	47	42	89	5	11
Bronchography	19	18	95	1	5
Bronchoscopy	33	28	85	5	15

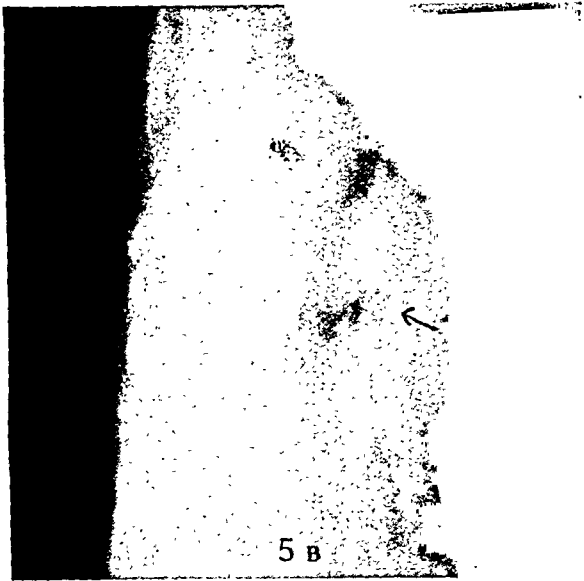
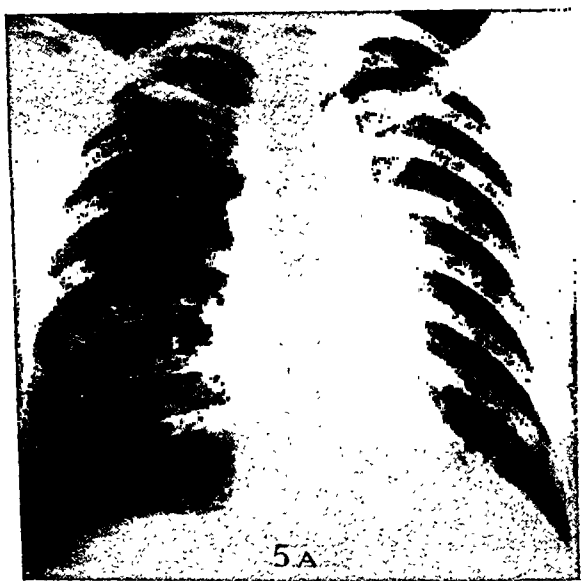


FIG. 5. Carcinoma of left upper lobe bronchus. *A*, posteroanterior roentgenogram exhibiting atelectasis of left upper lobe. The mass in the hilum is not clearly demarcated. *B*, planigram of same case 12 cm. from posterior chest wall. Note the abrupt ending of the air column of the left main bronchus (arrow). The lower lobe bronchus was seen to be fully patent in other films made in a more posterior plane. The deceptive appearance of an angulated bronchus is again shown in this planigram. In addition the large mass in the hilum is clearly delineated adding further evidence of the neoplastic nature of the obstruction.

for diagnosis and the results achieved are indicated in Table I.

It is evident at once that this is a selected group of cases and it is not intended that these figures should serve as any indication of the relative value of the designated methods. As in all diagnoses of chest dis-



FIG. 6. Carcinoma of the right upper lobe bronchus, planigram 8 cm. from the posterior chest wall. Note the characteristic irregular constriction of the upper lobe bronchus (upper arrow) which was better demonstrated in a more anterior plane. The lower lobe bronchus is clearly delineated and a typical infiltration and narrowing of its lumen (lower arrow) is apparent. There was involvement of the peribronchial lymph nodes with extension into the lower lobe bronchus.



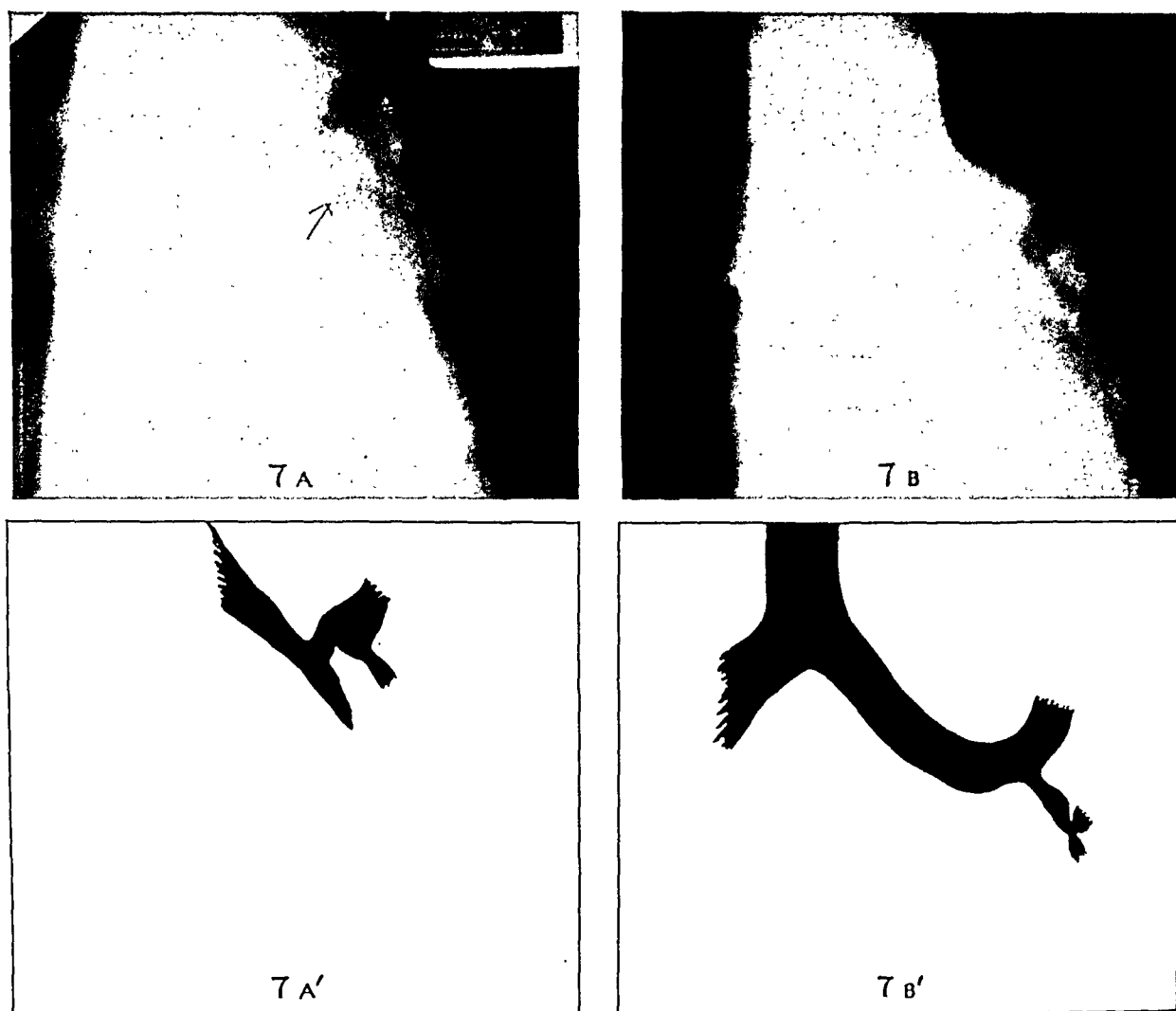


FIG. 7. Carcinoma of the left lower lobe bronchus. *A*, planigram 11 cm. from posterior chest wall. The left main bronchus and its branches are demonstrated. The lower lobe branch (medial arrow) is seen to be stenosed in fairly irregular fashion. The upper lobe bronchus and its lingular branch (lateral arrow) are not so clearly delineated. *A'*, diagram from a tracing of *A*. Both the stenotic lower lobe branch and the upper lobe branches are shown. *B*, planigram at 12 cm. level. The upper lobe bronchus is well shown and the lingular branch (arrow) is especially clear. At this level the lower lobe branch cannot be observed. The intact upper lobe bronchi are thus delineated in one section while the stenotic lower lobe bronchus is seen in another section. *B'*, diagram from a tracing of *B*. Only the left main bronchus and its upper lobe branches are shown.

eases certain procedures are more applicable to certain cases. Selection of an adequate procedure must always be individualized. The purpose of these figures is only to indicate the possibilities of planigraphy as a supplementary or substitute method in certain cases.

The procedure of planigraphy was a failure in 5 cases the details of which are as follows: Coughing and dyspnea were sufficiently severe in 1 case to prevent proper cooperation. In another there was a pneumothorax present with a considerable col-

lapse of the lung and distortion of the bronchus. In a third case, the lesion was in the bronchus to the anteroinferior segment of the upper lobe. In the latter 2 patients the tumor was demonstrated by means of bronchography. In 2 additional cases underexposure prevented satisfactory visualization of the bronchi involved.

In many of the cases in which only a branch bronchus was obstructed, a mass could also be seen extending into the main bronchus from which the obstructed bronchus arose. The masses in these cases were

not sufficiently large nor did they extend far enough to obstruct other branch bronchi.

An interesting observation was the presence of good aeration in certain portions of the lung beyond what appeared to be a complete obstruction. The probable reason for this phenomenon is that deep inspiration allows the passage of air in one direction through a very constricted lumen. A somewhat similar situation is that of a partially aerated lobe, with segmental atelectasis, beyond what appears to be a complete ob-

The 5 cases in which planigraphy was unsuccessful had tumors in the following regions:

Right main bronchus	3
Left upper lobe bronchus	1
Right lower lobe bronchus	1

#### SUMMARY AND CONCLUSIONS

Planigraphy has demonstrated its effectiveness as an aid in the diagnosis of intra-bronchial masses. It is not intended to replace the older methods of diagnosis, which are still extremely useful and in certain

TABLE II

PLANIGRAPHIC DELINEATION OF BRONCHIAL TUMORS—42 CASES

Right		Left	
Multiple bronchi.....	3	Multiple bronchi.....	3
Main bronchus.....	2	Main bronchus.....	3
Upper lobe bronchus.....	8	Upper lobe bronchus.....	4
Lower lobe bronchus.....	12	Lower lobe bronchus.....	4
Middle lobe bronchus.....	2		
Middle and lower lobe.....	1		

struction of the main bronchus to that lobe. An explanation, somewhat questionable, has been made that there is collateral aeration through the interlobar fissure from the adjacent uninvolved lobe.

By means of bronchoscopy, tumors were demonstrated in 28 of the 33 cases in which it was used. Of the 5 failures, 3 were in patients with lesions of the lower lobe bronchi, 2 of them on the left; 2 were in the upper lobe bronchi, 1 on each side. In 3 of these cases the defect was successfully demonstrated by both bronchography and planigraphy; in one it was delineated by planigraphy, in the other by bronchography.

Bronchography was possible in 19 cases and successful in 18 of the total with only 1 failure. The failure was in a patient who was coughing severely. The small number of cases submitted to bronchography indicates the high percentage of patients in whom the examination was found to be inadvisable or impractical or in which planigraphy had proved to be an adequate substitute.

The various bronchi in which tumor or obstruction were demonstrated by planigraphy are indicated in Table II.

cases more accurate, but it represents an adequate supplementary and substitute procedure.

Its accuracy compares favorably with other roentgen methods of diagnosis. It offers great advantages in the lack of complications and contraindications which affect other types of examination such as bronchography and bronchoscopy. It can be used in many cases in which other methods are impossible.

Certain details concerning the technique used in this clinic have been given in the hope that slight aid may be offered to those contemplating the use of this procedure. If certain general principles are followed satisfactory results can be obtained.

A report of 47 patients with bronchial tumors in which planigraphic studies were made is presented and illustrative cases are detailed.

A total of 47 cases were examined by planigraphy and failures were noted in only 5 cases. Experience with the procedure will reduce the number of failures appreciably. Bronchography failed in only 1 of the 19 cases examined but it is noted that in many cases this method could not be used.

If continued progress in improving the

technique of planigraphy is maintained it may reduce the importance of other methods of examination of the bronchi.

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#### DISCUSSION

DR. SHERWOOD MOORE, St. Louis, Missouri. This paper is of such excellence that very little discussion is called for. It is very timely and all that I can contribute, if anything, is commendation and a few details regarding methods.

In our clinic, carcinoma of the lower respiratory tract is exceedingly common. I do not know the relative percentage, but it is very high and I am convinced that carcinoma of the lower respiratory tract is actually on the increase.

That fact calls for the best diagnostic effort

of every radiologist. It also indicates that the most refined methods which we are capable of using should be employed. My recollection is that 75 per cent of the cases of bronchogenic carcinoma in our clinic are hopeless and virtually terminal by the time they reach us.

Therefore, any method which will increase our accuracy of diagnosis before that late stage has arrived is to be employed. I do not believe that the cost of doing this work resides so much in the films, an objection which I have frequently heard at our meetings—it isn't the film that costs, but rather it is the labor because this procedure requires much time, and the more accurately it is done the more time is required.

As Dr. Rigler said, it is a supplemental type of examination and should always be preceded, of course, by conventional roentgen examinations. I do not believe it should be resorted to (where indicated) before bronchography or bronchoscopy is done.

Any one of you can learn from any of a number of publications how to build the so-called home-made planigraph or whatever you choose to call it. I constructed one myself at a cost of fifteen dollars, and it did excellent work. I prefer to use the more elaborate apparatus because it gives better results.

As for details of methods, one should have enough sections to be sure that one is not being deceived by a change of depth of focus, which Dr. Rigler has so beautifully demonstrated in the bronchus angulating and turning out of the plane of focus. The depth of focus is of the order of one centimeter. The conventional films, especially the lateral, determine the distance of the suspected area from the posterior or anterior thoracic wall. The patient is placed supine or prone, depending on which will bring the suspected area nearest to the film.

Where there is no guide, several films at 1 cm. depths should be made, as Dr. Rigler has shown; several from the midline to the posterior wall, and several in the opposite direction.

This is an extremely helpful method, particularly in the upper sections of the lungs where, as Dr. Rigler has pointed out, bronchoscopy with biopsy is difficult and often impossible, and where bronchography also frequently fails.

## BENIGN PNEUMOCONIOSIS DUE TO METAL FUMES AND DUSTS\*

By O. A. SANDER, M.D.  
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THE term "pneumoconiosis," first used by Zenker<sup>8</sup> in 1867, requires redefinition because it is so widely misunderstood. Its generic meaning simply is "dust added to the lungs," without any implication of what reaction may or may not have resulted from the dust. Only two dusts are known to cause significant fibrotic reactions in the lungs: free silica and asbestos. However, because silicosis and asbestosis are the best known pneumoconioses, the terms "fibrosis" and "pneumoconiosis" unfortunately have become almost synonymous in many medical minds.

The benign pneumoconioses, therefore, are those resulting from inert dust deposits in the lungs, which are not the cause of any fibrosis or disability. Siderosis is one of these, as shown in the case reported by Enzer and myself<sup>2</sup> in 1938, in which a tank welder who showed roentgen changes simulating silicosis had no fibrous tissue in the lungs when studied at postmortem. The roentgen shadows simulating silicosis were shown to be due to aggregations of radio-paque iron particles in the lymphatic channels and nodes surrounding the blood vessels and bronchi.

These findings differ from Zenker's original description of siderosis, in which he implied that the iron dust inhaled into the lungs was the cause of the associated fibrosis. This early concept is understandable when his reported cases are analyzed, each actually having fibrosis not due to iron, however, but to associated tuberculosis or silicosis. Also, later pathological reports of siderosis in iron miners' lungs usually were cases of sidero-silicosis, the observers erroneously concluding that the iron was the cause of the fibrosis rather than the silica. The term "siderosis," therefore, is a perfectly proper one to use for this type of benign pneumoconiosis,

provided the implication of fibrosis is excluded.

A number of different occupations appear to have been responsible for the development of siderosis besides the electric welding described by us. It was with surveys of hematite iron ore miners in England that it was first suspected that the hematite itself might be casting some of the shadows seen on the roentgenogram. A radiologist named Thurstan Holland is quoted by Fawcitt<sup>4</sup> as first suggesting this possibility as early as 1919, but it was doubted by Collis and others because of the solubility of the iron oxides. Fawcitt, however, cites a postmortem study of a hematite miner made in 1936, in which "no undue fibrosis was found," but aggregations of hematite particles in the lung lymphatics were believed responsible for the "snowflake mottling" seen in the roentgenogram.

More recent postmortem proof that iron oxide particles may form aggregates in the lung lymphatics is offered by McLaughlin, Grout, Barrie and Harding,<sup>6</sup> also of England. Their case was a man, aged fifty-four, who had been a silver polisher for forty years in which work "rouge" ( $\text{Fe}_2\text{O}_3$ ) is used as the abrasive. Their microscopic sections resembled in every detail those reported by us in the electric welder in 1938, including a complete absence of fibrosis. The roentgenogram also resembled the discrete stippling seen in our electric welders. Other similar cases among silver polishers were cited as showing the same roentgen appearances, which they attributed largely to siderosis.

Hamlin<sup>5</sup> recently described similar roentgen changes in foundry grinders and burners, in which the silica exposure had been insufficient to account for the nodulation seen on their roentgenograms. The iron

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

oxide exposure, however, had been sufficiently high to warrant the conclusion that their nodulation was due largely to iron collections in the lymphatics. Unfortunately, the opportunity for postmortem proof in these cases has so far not presented itself. Pendergrass and Leopold<sup>7</sup> have reported 4 suspected siderosis cases in metal grinders in which they had evidence by an engineering study of insufficient exposure to free silica dust to warrant a diagnosis of

operation. We did not realize until after our electric welder study that the fumes released during the gas cutting of metal contains the same oxides of the metal being cut as with electric welding and that these are in extremely fine particulate dispersion (less than 0.5 micron) and in extremely dense concentrations (upwards of 100 million particles per cu. ft.). Although these cutters were known to be inhaling some free silica dust which is

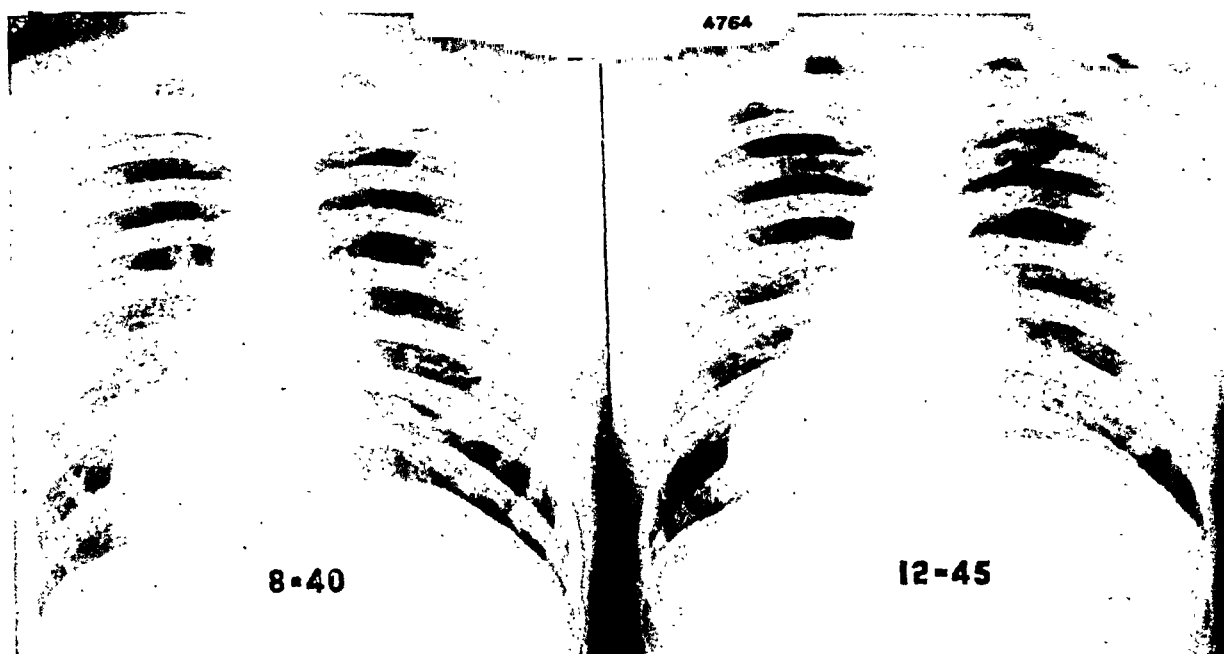


FIG. 1. Case 1.

silicosis. Another occupation presenting similar exposure factors and roentgen appearances is that of boiler scaling, recently reported in England by Dunner,<sup>1</sup> but post-mortem proof also is lacking here.

I should like to add to this growing list of occupations which may be siderosis producers that of metal cutting with the oxyacetylene flame. In our roentgen surveys of foundry workers dating back to 1933, we were at a loss to explain why these gas cutters working in the foundry cleaning rooms developed nodular silicosis more rapidly than did other employees in the same room. We at one time suspected that the heat of the flame might be volatilizing some of the adhering molding sand, and therefore urged that the castings be more thoroughly cleaned before the cutting

present in varying degrees in all foundry cleaning rooms, the silica exposures were too low to account for the nodulation which was appearing in from six to eight years of this work. We now believe that the nodulation in many of these cases is largely due to siderosis, with little if any associated silicosis. Only a few which appear most representative will be reported here.

#### REPORT OF CASES

CASE 1. L. P., aged thirty-five. Oxyacetylene cutter in steel foundry cleaning room since 1933. No previous dust or fume exposure. Chest roentgenogram still clear in 1940 after seven years of exposure, but gradual development of discrete nodulation or stippling since then. Silica exposure slight, but fume exposure heavy during past five years of increased war production. Has no symptoms of any kind and physi-

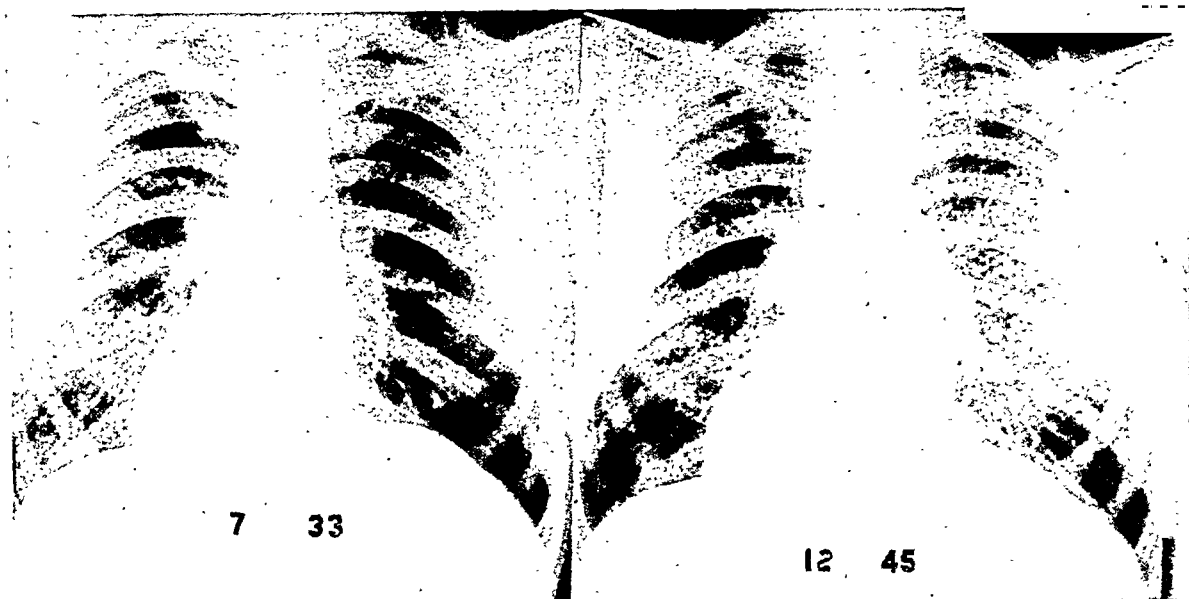


FIG. 2. Case II.

cal findings negative. Will continue at regular work.

CASE II. H. O., aged fifty-seven. Oxyacetylene cutter in steel foundry cleaning room for past twenty-four years. No previous dust or fume exposure. Chest roentgenogram in 1933, after twelve years of exposure, shows early discrete nodulation. This has increased only slightly in past twelve years. No symptoms or physical findings in chest. Will continue at regular work.

CASE III. J. S., aged thirty-two. Oxyacetylene cutter in steel foundry cleaning room for ten years (began 1934). Clear lungs to January, 1943, after nine years of exposure, followed by gradual development of discrete nodulation or stippling. Had attack of "flu" or pneumonia in January, 1944, but precise diagnosis not made and was not roentgenographed then. Next film in March, 1944 (Fig. 4), showed marked enlargement of root lymph nodes, with persisting dyspnea and cough. Symptoms gradually subsided during next six months and root nodes

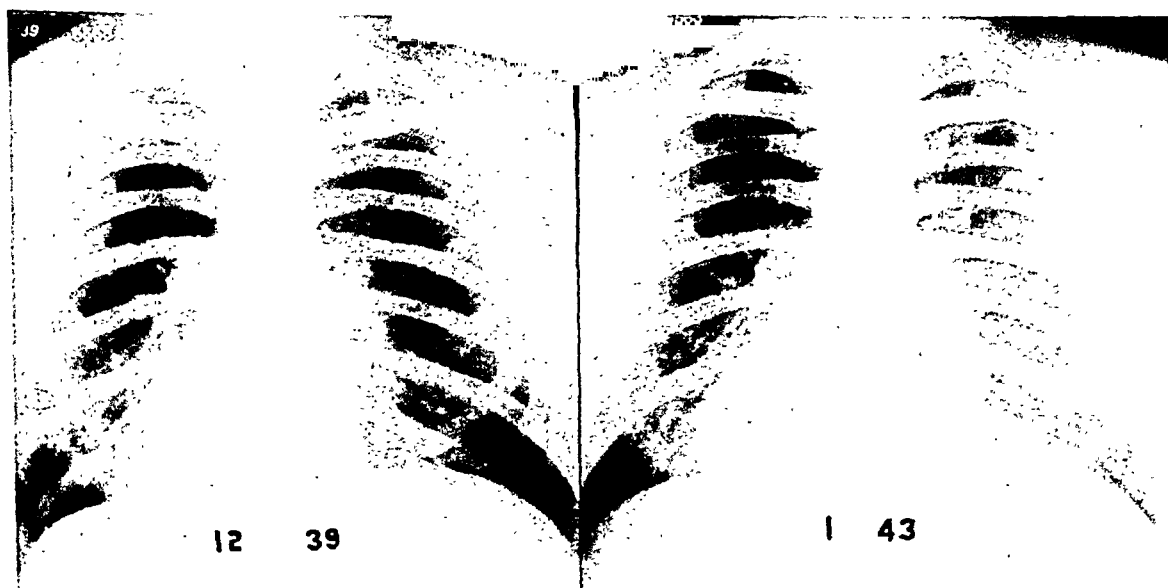


FIG. 3. Case III.

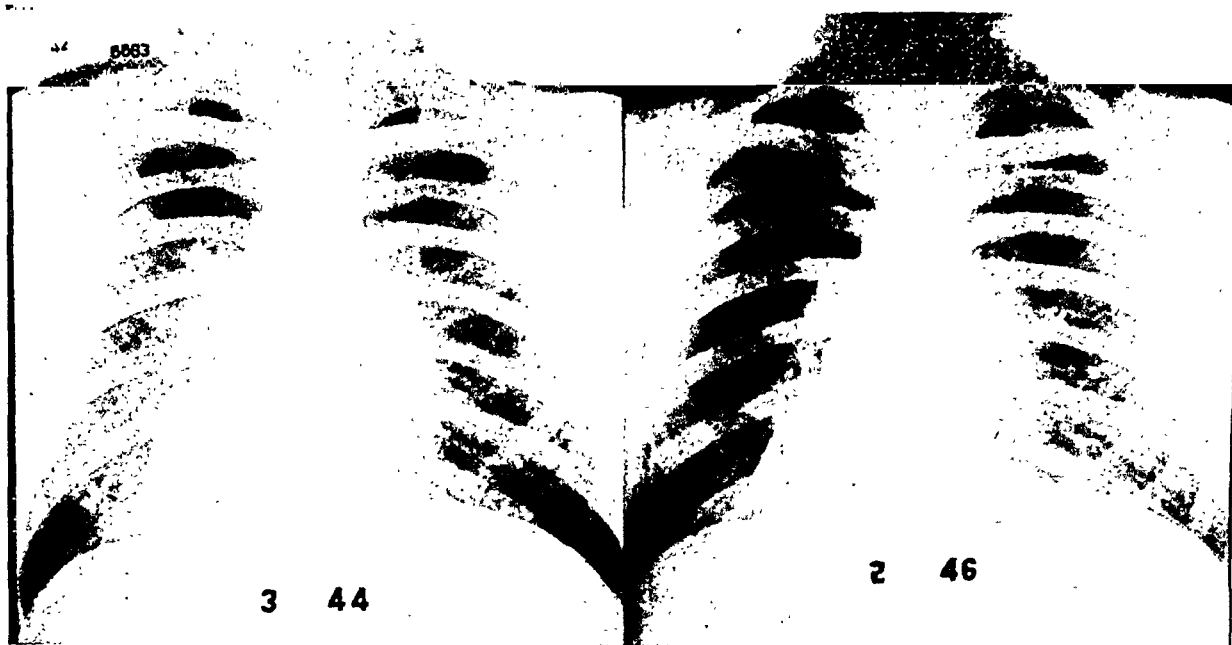


FIG. 4. Case III.

gradually returned to normal size. Has no symptoms now and is working daily. Generalized nodulation or stippling continues.

These 3 cases have the following diagnostic points in common, which are similar in every way to those described for the electric arc welders:

1. Discrete and rather sharply defined rounded shadows, of more or less uniform size and equal distribution in both lungs.

2. No tendency to confluence of the shadows.

3. Hilum shadows always smaller than would be expected with silicosis of this degree (except during infections).

We have not seen any of these cutters with associated progressive tuberculosis, which is further evidence that they are primarily siderosis cases with little or no silicosis. Non-tuberculous infections, as suggested by the probable pneumonitis and lymphadenitis of Case III, also appear to clear up completely, indicating no obstruction of the lymphatic circulation. Moreover, there has been a complete absence of symptoms with all of these cases, except during episodes of acute infections. Even with our electric welders with rather marked roentgen changes, there has been no measurable impairment of lung function.<sup>3</sup>

So far there has not been an opportunity for postmortem study of any of these cutters. Some of them may have some silicotic nodulation in addition to the iron pigmentation but, for the reasons given, we believe that their roentgen shadows are due primarily to the aggregations of radio-paque iron particles in the pulmonary lymphatics surrounding blood vessels and bronchi.

In closing, I should like to make a plea to all physicians to be on the alert for more postmortem studies of cases showing nodular roentgen-ray patterns. Too few have been adequately analyzed and the findings correlated with the roentgen appearance. Too often, also, gross black pigmentation at postmortem has been erroneously diagnosed as anthracotic, when ferrocyanide stain of the sections would have made the differential diagnosis by revealing the Prussian blue reaction for iron. Gross round lesions also have been incorrectly diagnosed as silicotic without use of the connective tissue stains to determine if they were true fibrotic nodules. These differential procedures are recommended with all cases showing nodular or stippled roentgen shadows.

Finally, more careful analysis of past dust exposures is recommended whenever

a roentgenogram showing nodular shadows presents itself for an opinion. It is not enough to obtain a history of foundry work, mining, or grinding. The precise environmental conditions must be determined, which frequently requires sampling of the atmospheric dust and its detailed analysis by an expert industrial hygienist. "Pneumoconiosis" alone no longer can be considered an adequate diagnosis because the benign pneumoconioses must be differentiated from those which may be disabling and progressive. All that is nodular by roentgen-ray is by no means silicosis and we owe it to labor and industry alike to prevent unfortunate mistaken diagnoses which always are so upsetting to all concerned.

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#### DISCUSSION

DR. PHILIP J. HODES, Philadelphia, Pa. Dr. Potter was to have discussed Dr. Sander's paper, but is ill. Having been drafted but a few moments ago, I cannot bring to this discussion the studied consideration it merits.

Dr. Sander's report is timely and important. It is timely because of the new techniques being developed by industry for handling metals, organic solids, liquids and gases; some of which are potentially dangerous to employees. It is important because it throws considerable light upon the bronchopulmonary complications which he recognized in workers exposed to metal fumes and dusts.

Not many years ago, men interested in pneumoconiosis believed that the small nodules described in classical silicosis were found only in individuals exposed to silicon dioxide,  $\text{SiO}_2$ . Though unable to explain the appearance of "silicotic nodules" in men with no known exposure to silica, the presence of silica was usually postulated in order to explain the roentgen findings.

Evidence gradually accumulated, however, that seemed to indicate that among other industries, barium workers, iron workers and even cotton workers developed bronchopulmonary changes similar to those thought previously characteristic of silicosis. Now Dr. Sander tells us similar pulmonary nodulations may be found in workers in metal fumes and dusts. His illustrations leave no room for doubt.

I am impressed by several features in the latter. First, Dr. Sander did not show us any roentgenograms in which pulmonary fibrosis of the type seen in silicosis was evident. Indeed Dr. Sander feels pulmonary fibrosis is not part of this picture. This is extremely important because of its bearing upon prognosis. It is probably too soon to be sure that these patients will not go on to develop massive pulmonary consolidation.

Second, it seemed to me that the pulmonary nodules seen in these metal fume workers were a little smaller and more clear-cut than the nodules seen in silicosis. I would hesitate to try to differentiate the two, however, on this evidence alone.

It is obvious that no roentgenologist could hope to offer an etiologic diagnosis in these patients without an adequate occupational history. No index of suspicion could possibly be high enough to make this diagnosis based solely upon the films of the chest. This is but another example of the interdependence of clinician and roentgenologist. Cases like these will go unrecognized unless the roentgenologist sees his patients personally and seeks help from his consultants constantly.

I have two questions to ask of Dr. Sander.



First, does he have any information concerning the gaseous exchange in the lungs of these patients? Second, have any of these cases yet come to litigation?

May I take this opportunity to congratulate the essayist upon the excellence of his presentation and thank him for sharing this important information with us.

DR. FREDERIC E. TEMPLETON, Seattle, Wash. In listening to these papers, it appears to me that we are confusing the issue by trying to make a microscopic and chemical diagnosis from a roentgenogram. There are many substances which cause these conditions in the lungs. At Cleveland, we encountered beryllium. There was the nitrous oxide poisoning at the Cleveland fire. There is iron and silicosis. When we look at a neoplasm, we cannot always make a microscopic diagnosis.

I wonder if we cannot simplify the problem by throwing all these conditions into one group, chemical pneumonitis, if you please. From there on the definition is a clinical problem.

DR. L. G. RIGLER, Minneapolis, Minn. I wasn't going to discuss Dr. Sander's paper but Dr. Templeton touched me on a very raw spot. We do make the diagnosis of tumors from roentgen examination very frequently and we are very frequently right, and I see no reason why we should adopt a defeatist attitude about that or anything else simply because we cannot always be right.

That is the implication of saying "This is a spot on the lung" rather than saying what we think it is. Obviously, there have to be certain limitations and we have to recognize them but I wouldn't accept the idea that we should refrain from making microscopic diagnoses because it would be a sad mistake if we did.

I would like to ask Dr. Sander a question in relation to this. It has appealed to me since some contact with arc welders awakened me to this particular problem. That is with regard to the matter of benignity of the lesion. Waldenstrom, and others,—and we have seen one or two cases ourselves—have reported cases of what he called hemosiderosis pulmonum. That is in relation to sideropenic anemia, there is bleeding from the lungs from time to time over a period of years producing a hemosiderin deposit.

I realize this is a very different kind of iron, and it is deposited in the alveoli. Nevertheless,

it was found that it was just iron and these patients die of suffocation from fibrosis. There isn't much doubt about that, as shown at autopsy examination.

I am not sure it is comparable and I would be glad to hear Dr. Sander discuss that. I am wondering whether we are justified in assuming the benignity of this finding in light of the fact that all of us see real silicosis with nodulation, in which the patients are entirely symptom free and if we didn't follow them long enough or if the exposure didn't continue, we would consider the lesion also entirely benign.

I wonder if we have had enough experience with siderosis to draw the conclusion that it is a benign dust.

DR. SANDER (closing). The only physiological studies which have been made of welders showing these deposits were reported in 1945 by Enzer and his co-workers at Mount Sinai Hospital in Milwaukee, in which they included 15 welders showing these changes, with a control group of 15 foundry workers with definite nodular silicosis and an additional control group of the same approximate age without any lung changes. Numerous tests were made which are too numerous to mention here, but the final result showed that the welders had completely normal response to these exercise tests, comparing favorably with those who were entirely free of any chest pathology, whereas those with silicosis showed a slight impairment of lung function.

The other evidence is that we have not seen any with symptoms and they are working daily without any impairment. I do not know that these lung changes have any status in the courts because I do not know that any have come to trial. I believe, however, that we have fairly convincing evidence that it is not a disabling condition at this time and it seems unlikely that any disability will result from these deposits in years to come.

On the question of hemosiderin, we have considered that possibility in these cases. Hemosiderin deposited in the alveoli in sufficient degree undoubtedly will cast shadows. But the iron in these welders is intracellular; i.e., within the phagocytes in the lymphatics of the lungs, and it does not stay in the alveoli. Furthermore, complete blood counts on all of our welders and cutters have not revealed any evidence of anemia.

# SPONTANEOUS HEALING OF LOCALIZED HEMATOGENOUS SPREAD IN PULMONARY TUBERCULOSIS

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## I

SPONTANEOUS healing of tuberculous changes disseminated in the lungs and associated with cavitation has been described in a previous paper<sup>3</sup> (1944). The patients concerned were in good general condition, apyrexial and devoid of physical signs. This "cavitation complex" was shown to be subject to healing by resolution, fibrosis or calcification. Changes which had some features in common with the cavitation complex were mentioned in cases of extrapulmonary tuberculosis by Miller<sup>5</sup> (1934), Reisner<sup>8</sup> (1934), and Tepper and Jacobson<sup>11</sup> (1934). Spread and cavity need not necessarily occur together. Spontaneous healing of a spread of the type described may occur alone. Twenty-five such cases form the subject of the present paper.

As a rule the history has no significant features and the disease was only discovered roentgenologically. General condition of the patient was reasonably good and physical signs, if at all present, were few. The lack of râles, even post-tussic, is of high diagnostic significance, as will be substantiated later.

The sputum contained tubercle bacilli, sometimes only detectable after repeated examinations.

Roentgen examination nearly always proves surprising, as it discloses a characteristic spread essentially identical with that found in the "cavitation complex," namely an evenly distributed rather closely packed spread, mainly of small sized foci, which seem to have developed simultaneously. Unlike cases of advanced phthisis, in which tuberculous patches are often discernible, indicating that one apparently older tuberculous area has conveyed some tuberculous material into an other, a

tuberculous source in the lung cannot here be seen. The absence of such source of spread due to bronchogenic aspiration and the even distribution of the foci suggest hematogenous rather than bronchogenic origin, although it is, admittedly, not always possible to exclude such cavities or to differentiate roentgenologically between hematogenous and bronchogenic spread.

Larger patches observable in some patients among the small foci may be due to confluence of smaller foci, or may consist of a small tuberculous core with perifocal inflammation of which proof is afforded by Case VI, in which the first roentgenogram shows a spread with patches varying in size, while the second roentgenogram taken after seven months' rest reveals very distinctly evenly distributed small foci.

The extent of the spread varies: in some cases it is found only in one zone, in others in a whole lung field, while there are cases in which the upper zones of both lungs have been affected, or there may be even more extensive involvement.

Several patches of spread may occur at varying intervals in the same patient. An adjacent area may coalesce with the first one, or the second area may appear at some distance from the first one, or even in the other lung field.

The type of pulmonary tuberculosis described is marked out by its tendency to spontaneous healing which may take place as early as within six months, the longest interval observed in the present series being six years. It is permissible to assume complete healing when the roentgenological manifestations have disappeared and when numerous sputum tests have been found to be negative. Cough and sputum may still persist, however, for some time.

Such healing, as has been described, does, of course, not exclude further manifestations of tuberculosis from developing at a later date either in the lung or any other organ. In this connection it is worth mentioning that 2 patients in this group subsequently developed (but before the roentgenological manifestations had disappeared) a fatal meningitis. No necropsy was performed.

Not all cases of the type described heal

limited and/or situated in an area of the lung some distance from the chest wall. This assumption that the spread is limited to the interstitial tissue might perhaps account for the tendency to spontaneous healing. The presence of air has been thought to be favorable to the growth of tubercle bacilli and to the development of tuberculous tissue in the lung. The fact that the spread is localized in the interstitial tissue and thereby cut off from the air might be regarded as the cause of the promotion of healing. Similar conditions are likely to be predomi-



FIG. 1. Case 1. Vera D. A, May 20, 1943, uniform distribution of small foci in left upper and mid-zone B, June 21, 1944, resolution.

spontaneously. Some deteriorate, as can be seen roentgenologically; clinically râles can be found which had not been audible at the time of the initial observation.

As to the nature of this type of pulmonary tuberculosis and its tendency to spontaneous healing the following tentative explanation may be submitted. The foci appear to be the result of a hematogenous spread into the interstitial tissue of the lung. As long as the spread is localized in the interstitial tissue, there are no râles which, if present, would indicate the contact of (tuberculous) material with air. When some sporadic foci penetrate into the alveolar and/or bronchial system, some sputum containing tubercle bacilli may be produced. Râles will not be audible, however, if this development is

nant in chronic miliary tuberculosis which is known to be prone to spontaneous healing. The course of the disease in our group depends upon whether or not the spread remains limited to the interstitial tissue. If foci develop and penetrate *on a larger scale* into the air passages, râles can reasonably be expected.

It is advisable to distinguish between cases in which (post-tussic) râles are audible and those in which they are not. The former have not the same tendency to spontaneous healing as the latter. But a decision as to the presence or absence of râles should not be made before the patient has had a complete rest of about ten to twelve weeks, after which time any râles present may

have disappeared. It is important to make this distinction, for it has a practical bearing. It has been for many years the generally accepted opinion that most of these cases are suitable for active therapy, in particular artificial pneumothorax. By a fortunate chance the opportunity occurred to follow up cases of that group which had not been subjected to active therapy. Now having

deterioration. On the other hand, when the patient gains weight, when cough and sputum decrease during the first three to four months of his stay in a sanatorium, a favorable view may be taken and a conservative attitude is justified. There is no necessity to detain the patient in a sanatorium until healing of the tuberculosis is definite. The duration of treatment and

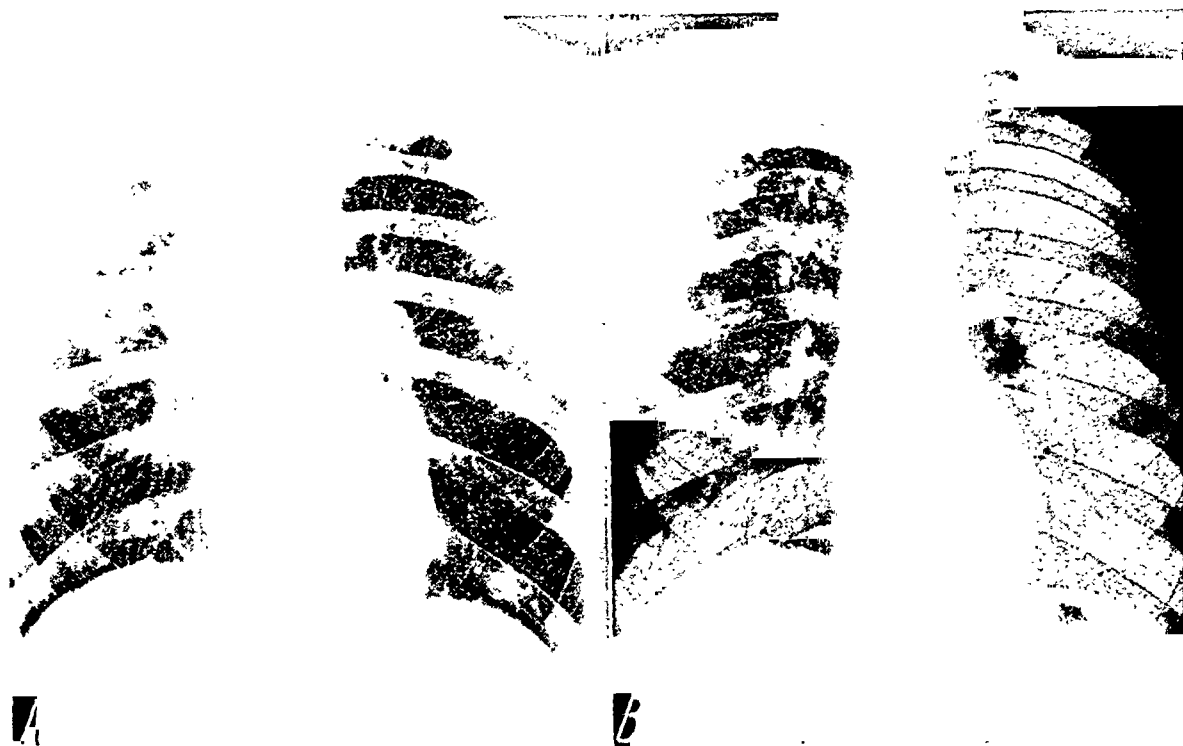


FIG. 2. Case II. Arthur W. *A*, February 24, 1938. Fine and coarse nodular infiltration in right upper and mid-zone. *B*, September 30, 1942, considerable resolution. Some clear-cut fibrotic and calcified shadow remain.

experienced their spontaneous healing, an expectant attitude seems worth trying in the cases described. The patient should stop work, have complete bed rest and should be under observation, preferably in a sanatorium for six to nine months, so that active therapy can be initiated in case of deterioration. But it is advisable not to be too hasty in commencing active therapy, as it may be a year or even more before improvement becomes noticeable. Even periods of deterioration may occur prior to the improvement. Although this is so, one cannot advocate an expectant attitude in cases of clinical and/or roentgenological

observation in the sanatorium, advice for living outside, permission to work, and so forth, should be judged individually in each case. It is worth mentioning that some patients have been followed up who did not stop work, as they always felt fit enough to carry on, nevertheless their hematogenous spread healed.

The suggestion of expectant therapy is not to be taken as a fixed rule. There are patients who cannot afford to be off work for a long time, and their doctor although knowing the possibility of spontaneous healing may wish to curtail the illness by active therapy. Considerations like that

are quite understandable. Healing which may take place following such measures must be critically assessed and should not be attributed to them exclusively. It is well to bear in mind that artificial pneumothorax treatment usually takes longer, apart from the complications which may happen during this treatment.

Observations made on 2 patients suffering from bilateral hematogenous spread give rise to

## II

In some cases the roentgenological manifestations of the hematogenous spread show a special feature. The clinical signs are the same as those described in the first part of this paper. Roentgenologically the spread consists of strikingly small closely set foci similar to millet seeds. The pattern of this type appears at first sight the same as that of miliary tuberculosis.



FIG. 3. Case III. Lilian D. *A*, March 12, 1942. Even distribution of small foci in left upper and mid-zone. *B*, October 25, 1943, resolution, residual fibrosis.

special consideration. In both patients an artificial pneumothorax had been induced in one lung. For reasons unknown to me an artificial pneumothorax was not induced on the other lung. Both, the lung treated with artificial pneumothorax and the other not so treated, healed approximately simultaneously. It is usual to attribute the healing of the second lung to a so-called contralateral artificial pneumothorax. Mentioning those 2 cases the existence of a contralateral artificial pneumothorax and its efficacy should not be denied. But having experienced the spontaneous healing of hematogenous spreads, some doubts are justifiable as to whether it is necessary in *these 2 cases* to regard the contralateral artificial pneumothorax as an explanation of the healing of the other lung.

In typical (acute and chronic) miliary tuberculosis both lungs are rather uniformly affected, whereas in our cases only one or several circumscribed areas in one or both lungs are affected. The name "localized miliary tuberculosis" might suitably be given to distinguish the cases concerned. On the extent of the spread depends whether a total bilateral or a localized miliary tuberculosis develops. The tendency to spontaneous healing generally recognized to be a feature of total bilateral miliary tuberculosis is also characteristic of localized miliary tuberculosis. The manner of healing is the same as that described in the first part of this paper.

Some cases of localized miliary tuber-

culosis have been followed up, in which there was no proper healing, but an obvious benignity has been predominant in that both the clinical and the roentgenological findings remained unchanged.

Several spreads of localized miliary tuberculosis may occur in different areas of the lung in the same patient.

It may be that a miliary spread takes place, apart from the lung, in some other

spread in the cases concerned. The roentgenological manifestations, especially those of the miliary type in addition to the absence of a source of bronchogenic spread (cavity) suggest hematogenous as against bronchogenic origin of the lesions. The objection raised by the opponents of the hematogenous theory, that there does exist a small cavity undiscernible on the film, is not valid. If it were justified, it

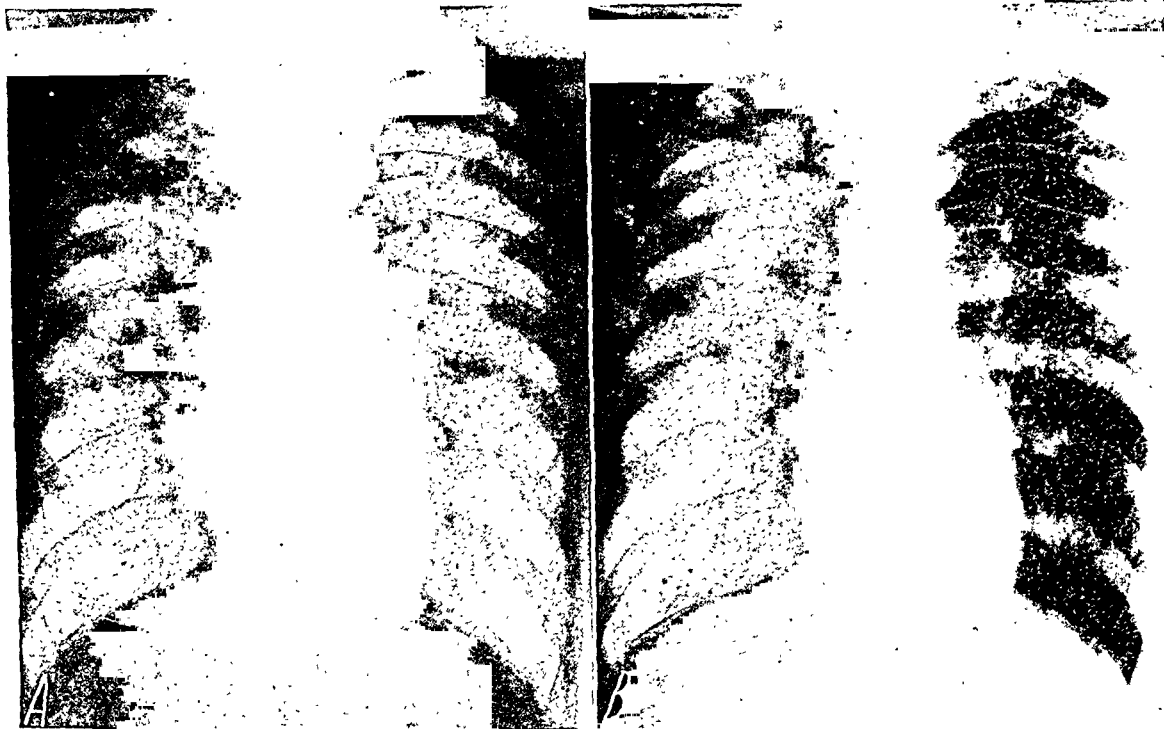


FIG. 4. Case IV. John C. *A*, May 11, 1936. Extensive bilateral mottling with confluence of foci in right and discrete nodular involvement in left. *B*, May 1, 1942. Numerous small calcified foci in both lungs.

organs either simultaneously with the spread in the lung or independent of it. A spread into the meninges has been observed. One of our patients died of meningeal spread two years after the localized miliary tuberculosis in the upper zone of the right lung had been diagnosed.

### III

The main purpose of this paper is to draw attention to the spontaneous healing of a uniform extensive or localized tuberculous spread in the lung. The cases on which the observations are based lead up to a short discussion of the nature of the

might be made during interpretation of any film, irrespective of whether it shows pathological manifestations or not. Furthermore, one could never assume the healing and disappearance of any tuberculous lesions, let alone of a cavity.

The spread is thought to have been established in the interstitial tissue, not having a communication with the air passage. In the clear cut cases described above râles, even post-tussic, are absent. Râles come about *within* the canalicular system, when fluid (or semisolid) material and air are mixed and moved during respiration. That is why special importance has been

attached to the absence of râles as a diagnostic criterion for the type concerned. On the other hand, even a hematogenous spread originally localized in the interstitium can, of course, growing proceed to the canalicular system and become in this way a bronchogenic tuberculosis, which then clinically presents râles. For the pathology and pathogenesis two papers by Rubin<sup>9,10</sup> should be consulted. Rubin dis-

Later Neumann<sup>6</sup> followed him and coined the name of tuberculosis miliaris discreta. This group has been described in France as *granulie froid* by Burnand and Saye.<sup>2</sup> "Localized miliary tuberculosis" thus appears to be a clinical subgroup of the hematogenous spread described above and essentially identical with the tuberculosis miliaris discreta of which pathological evidence has been adduced by Pagel<sup>7</sup> (1936,

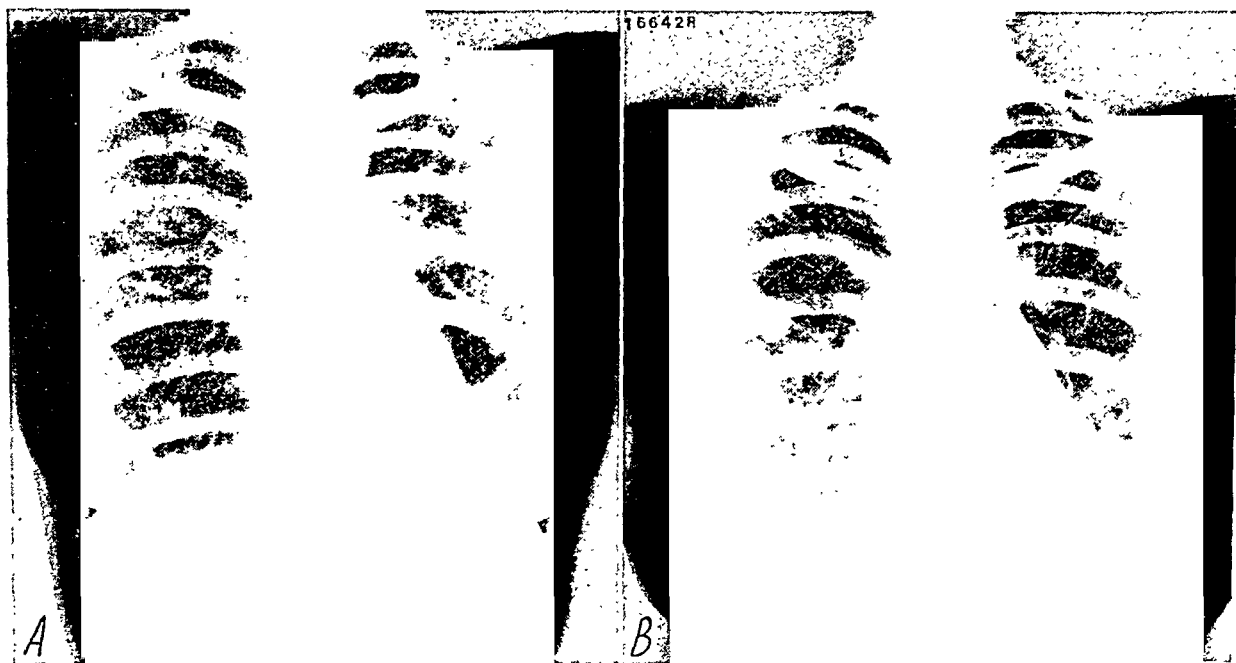


FIG. 5. Case v. Sarah N. *A*, July 19, 1941. Mottled infiltration with nodules of varying size in both lungs. *B*, July 28, 1944. Resolution. Bilateral fibrosis and slight calcification on the level of right second rib.

tinguishes two main types of hematogenous spread: one due to spread via the bronchial arteries resulting in an interstitial spread, the other one by the pulmonary arterial route with tubercles developing in the terminal air sacs and bronchioles.

It has been alleged that hematogenous spread is bound to be bilateral and symmetrical and that unilateral occurrence excludes blood-borne dissemination. Several of the cases described in this paper support Pagel's<sup>7</sup> contention that typical manifestations of hemic (disseminated) tuberculosis may be unilateral.

The conception of hematogenous origin of localized pulmonary tuberculosis was put forward as far back as 1901 by Bard<sup>1</sup>.

Such discrete miliary spread may be the result of a progressive resolution and diminution in the number of foci in what was originally a uniform widespread infection of the lung. All gradations from universal chronic miliary tuberculosis of the lung down to restricted collection of small foci in one small area are possible. Experimental evidence has been given that such restriction of the spread can be due to acquired immunity (Pagel, 1936).

Spontaneous healing of hematogenous spread has been documented by Reisner (1934) and Miller (1934). There is a far reaching agreement between Miller's and my own observations. It seems to be doubtful, however, whether the cases of

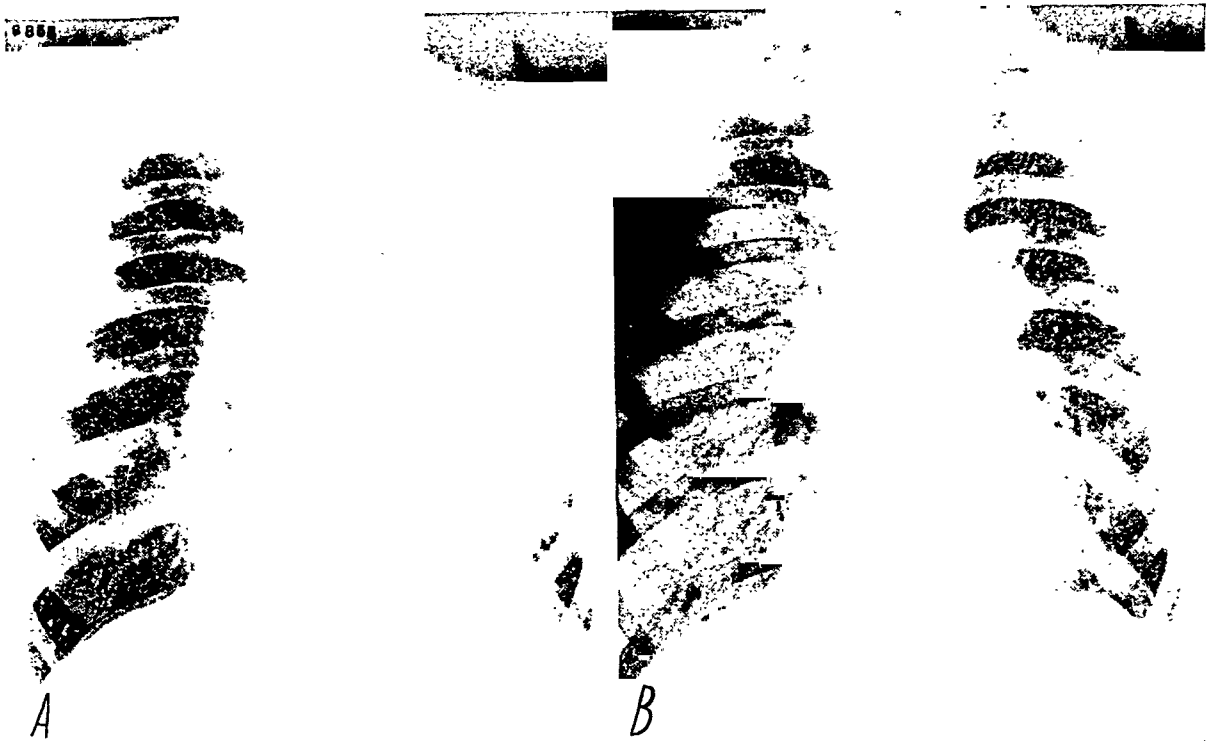


FIG. 6. Case vi. Norman S. To show that patchy infiltration may conceal an even spread of small foci. *A*, March 7, 1944. Patchy infiltration in left. *B*, October 18, 1944. After seven months' rest considerable resolution, evenly distributed small nodules remain.

Reisner and mine are of the same type. Dealing in his paper with the simultaneous occurrence of extrapulmonary tuberculosis he admits hematogenous dissemination in

patients with extrapulmonary tuberculosis; in none of my cases, however, were extrapulmonary manifestations found. Reisner seems to attach some importance to bi-

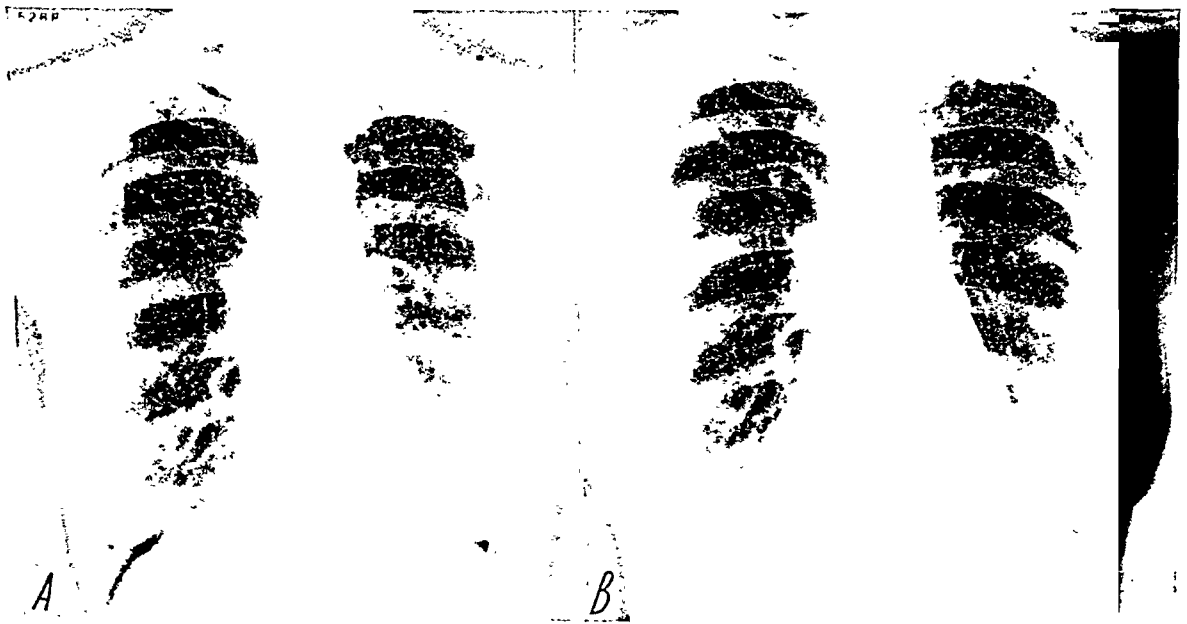


FIG. 7. Case vii. Lucy S. *A*, February 8, 1940. "Localized miliary" in mid- and lower zone. Large calcified mass in left apex. *B*, October 23, 1941. Resolution.



lateral spread with symmetrical involvement of both lungs to an equal extent, while I am in a position to have shown cases of unilateral spread, some of them affecting only a larger or smaller area of one side. Furthermore, the apicocaudal distribution, the foci gradually decreasing in number and in size from apex to base, with distinct predominance in the upper fields is supposed to be a striking feature in the cases of Reisner, but not in my cases. Unlike me Reisner stresses compensatory emphysema. Regarding spontaneous healing one may be inclined to question his assumption that foci, although no longer perceptible in the roentgenogram, may still anatomically exist, but escape detection due to their minute size (vide above).

#### SUMMARY

A type of pulmonary tuberculosis shows on the roentgenogram a characteristic *even* distribution of more or less closely set foci in larger or smaller areas (hematogenous spread), physical signs being absent. Cases of this type have some tendency to spontaneous healing by resolution, calcification and fibrosis.

A subdivision of this type is distinguishable on the roentgenogram by the pattern of "miliary tuberculosis," which is restricted to one or several circumscribed areas; the name "chronic localized miliary tuberculosis of the lungs" is proposed for those cases.

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# THE ROENTGEN APPEARANCE OF PRIMARY RETICULUM CELL SARCOMA OF BONE\*

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## INTRODUCTION

IN 1939 Ewing<sup>2</sup> reviewed the classification of bone tumors for the Bone Sarcoma Registry of the American College of Surgeons and accepted reticulum cell sarcoma as a primary bone tumor. In his report he stated that Kaufmann had recognized the existence of a pure reticulum cell sarcoma of bone marrow many years ago and that Oberling and Raileanu had later furnished a substantial basis for the segregation of this type of tumor. Parker and Jackson<sup>3</sup> in 1939 presented the first group of cases of primary reticulum cell sarcoma of bone. Of their total of 17 cases they were able to select 13 from a review of Bone Registry material, and to these they added 4 from their own experience. Theirs was a clinical and pathological study in which they emphasized the difference between primary reticulum cell sarcoma of bone and the generalized form of reticulum cell lymphosarcoma. Parker and Jackson pointed out that most of their patients were under forty years of age; that there was a predilection for the long bones with involvement of a single bone; that the patient's general condition was good; and finally, that the course of the disease was relatively long. Their findings contrasted significantly with those of Craver and Copeland<sup>1</sup> who in 1934 reported 17 cases of the generalized form of reticulum cell sarcoma having bone involvement. These patients were in an older age group, had involvement of multiple bones, chiefly spine and pelvis, and ran a retrogressive course. The majority died within three years of the onset of the disease and within one year following the appearance of bone lesions.

Since the work of Parker and Jackson a number of case reports of primary retic-

ulum cell sarcoma of bone have appeared in the literature.

We have had the opportunity of studying roentgenographically 17 cases of primary reticulum cell sarcoma of bone with adequate clinical, roentgenographic and pathologic data. Every case included in this group had at least one histopathological examination from bone. Dr. Fred W. Stewart confirmed the diagnosis on these patients. Selection of our material has been primarily on the basis of a dependable pathological diagnosis, together with satisfactory roentgenological studies and absence of generalized disease on admission.

The literature contains no study devoted to the roentgen diagnosis of primary reticulum cell sarcoma of bone. When the roentgenographic appearance has been touched upon, it was thought to be of little or no diagnostic aid. However, our experience indicates that there is a significant similarity in many cases of primary reticulum cell sarcoma. Furthermore, in certain instances we believe the appearance can be fairly characteristic. Recently we have been able to suggest the diagnosis to the clinician from the roentgenographic appearance alone.

Most bone tumors require histopathological proof for proper management whether the treatment be by surgery, irradiation or both. Nevertheless one must always consider the roentgenologic appearance as having a significant bearing on the final diagnosis. For an entirely acceptable diagnosis the clinical, the roentgenological and the pathological features must be consistent. It is particularly important when dealing with an unusual tumor that a close correlation of the three above mentioned elements exist.

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Bone tumors, whether benign or malignant, have a more or less characteristic roentgen appearance. This appearance must be critically studied and resolved into its basic components if one is to follow a systematic and productive approach to the roentgen diagnosis. This principle is to be applied in the following discussion of the roentgenographic diagnosis of primary reticulum cell sarcoma of bone. Specifically we are to follow here a more or less standard plan that we generally pursue in attempting to make a roentgen diagnosis in any bone tumor case.

#### ROENTGEN DIAGNOSIS

1. *Location in Skeletal System.* Of the 17 cases in this series 4 were located in the femur, 5 in the tibia, 2 in the humerus, 2 in the scapula, 2 in the vertebrae, and 1 each in the fibula and rib. In Parker and Jackson's cases 5 occurred in the femur, 3 in the tibia, 3 in the humerus, 4 in the clavicle and 1 each in the scapula and mandible. We have no cases in the skull or small bones of the hands or feet. In these 34 cases it is thus seen that four-fifths involved the tubular bones.

Seven tumors in our series arose about the knee, 3 being in the distal femur and 4 in the upper tibia. Seven of Parker and Jackson's cases were situated about the knee. It is interesting to note that in the combined group of 34 cases about 40 per cent were found in the region of the knee.

2. *Location in Bone.* This refers to the region in which the bulk of the tumor is situated, i.e., epiphyseal, diaphyseal or metaphyseal. It is most aptly applied to tumors occurring in tubular bones. Twelve of our cases were in tubular bones, 5 being located in the diaphysis. Three of these 5 were located in the mid-shaft while 2 were away from the center of the shaft. In the remaining 7 cases the bulk of the tumor was in the epiphyseal region but by no means always confined to it. In 2 cases in vertebrae the major site of involvement was the body. Of the scapular lesions in one the spine and in the other the spine and

glenoid were the site of the tumors and in the rib case the tumor was in the posterior part of the rib.

The epiphyseal line remained open in only 3 cases (Cases 4, 7 and 36). In one of these the tumor stopped at the epiphyseal line. In another the tumor while situated towards the end of the shaft bore no relationship to the open epiphysis. In the last case it appeared that the epiphyseal line was crossed by the lesion.

Location in bone would appear from these findings to have no particular significance in reticulum cell sarcoma.

3. *Site of Origin.* In designating the site of origin an attempt is made to state whether a tumor arises from cortical or medullary bone or from the periosteal structures. In 16 cases there seemed to be little question but that the process arose from medullary or cancellous bone. In a single instance (Case 1) there was a possibility that the tumor might have had a cortical beginning.

4. *Symmetry in Bone.* The concept of symmetry in bone concerns particularly the tubular bones. Its determination must be based on a study of both sagittal and lateral views and both the osseous and periosteal components of the tumor are to be considered. In those tumors we designate as being symmetrical the vertical axis of the tumor coincides with the axis of the bone. Considering here only the tumors occurring in long bones, 8 were asymmetrical and 4 were symmetrical or nearly so.

5. *Direction of Growth.* It may be of some diagnostic importance to note the course that a bone tumor takes as it grows. Enlargement may be within the medullary portion of the bone or it may be outwards into the periosteal structures. In our cases the growth tendency seemed to be endosteal, over half being contained almost entirely within the bone. In all but 2 of the remaining tumors the direction of growth was predominantly endosteal.

6. *General Configuration.* Careful study of sagittal and lateral views of most bone tumors should enable one to determine the

outline or configuration of the process. In evaluating this characteristic the periosteous as well as the osseous part of the tumor is considered. From a practical standpoint only a gross estimate such as fusiform, ovoid or spherical seems important. Excluding of necessity the 2 cases in vertebrae and 1 in rib, 9 tumors presented an ovoid configuration and 5 tended to be fusiform. The fusiform cases were all located in the shaft.

7. *Destruction and Production in Medullary Bone.* Destruction was present to some degree in every case and it was the predominant change in medullary bone in 11 of the 17 cases. In 3 additional tumors production and destruction were about equal in degree.

Productive change, i.e., the formation of normal bone, the deposition of osteoid material, or the presence of calcification, was a less commonly noted finding in the medullary bone area. In only 3 instances, all of which occurred in the upper tibia, was production more prominent than destruction, although in 8 cases the former was present to a slight degree. In 6 tumors there was no productive change.

These findings would indicate that medullary bone destruction is a constant and usually predominant feature over production in primary reticulum cell sarcoma.

8. *Structure of the Tumor.* The structure or pattern of reticulum cell sarcoma is not characteristic although it may be a helpful point in diagnosis. The structure of the osseous portion of this tumor is often a patchy arrangement of areas of destruction often associated with similar sized areas of production. There is no pattern in the periosteous part of the tumor, it being observed almost without exception that there was no calcification in the soft tissue tumor apart from the periosteal reaction.

9. *Boundary of the Tumor.* The boundary includes the osseous and periosteous parts of the tumor. One of the most constant features of reticulum cell sarcoma is its ill defined margins, the boundary being so described in every instance. The difficulty

of determining the precise extent of the tumor in bone was emphasized in several cases when after reparative changes had occurred following treatment the extent of the tumor was found to be greater than initially estimated.

10. *Condition of Cortex.* In all these cases cortical destruction was a constant finding. This varied from very fine irregular areas to wide sections of erosion, thinning and destruction. In no instance was there expansion of the cortex or marked cortical thickening. No well defined "cortical shadow" was encountered.

11. *Condition of Periosteum.* Periosteal change was not found to be a prominent feature of reticulum cell sarcoma. Excluding of necessity from consideration those tumors occurring in the vertebral bodies, 10 cases had varying amounts of periosteal reaction and 5 cases had none. In only 3 instances (Cases 2, 7 and 14) was the periosteal change moderately prominent. It was frequently necessary to search the roentgenogram carefully to detect any periosteal change. When there was periosteal reaction, it was of the lamellated type, being accompanied in several instances by a minute reactive periosteal triangle at one margin of the tumor. The perpendicular type of periosteal reaction was also noted in 2 cases, but in both of these the lamellated type of reaction predominated.

12. *Periosteal Changes.* Thirteen cases had roentgenographic evidence of a periosteal tumor component. Only twice did the size of the periosteal tumor exceed the area involved in bone. In 3 other instances the soft tissue mass was somewhat prominent. In the remainder the mass was small to minimal. The size of the mass appeared to have no relation to the duration of the disease.

13. *Joint Changes.* In those cases where the process was in the region of the knee, roentgenographic evidence of joint change was not uncommon. Of the 7 cases in this location synovitis was present in 5. In 1 patient (Case 1) the synovitis was the prominent feature on initial examination

elsewhere, leading to a presumptive diagnosis of tuberculosis. In no instance was the effusion a large one.

14. *Pathological Fracture.* There were 4 pathological fractures, 2 in vertebrae and 2 in the mid-shaft of an extremity. All these healed following radiation therapy. The vertebral bodies showed slight residual compression deformity and the humerus and femur presented some degree of malunion but gave functioning limbs.

15. *Multiplicity.* In none of these cases was there evidence that more than one bone was affected.

16. *Rate of Growth.* In several cases the tumor was examined periodically by roentgenograms for a few months during which the patient had no form of treatment. The most significant and complete observation series of this sort was in Case 15 where during five months periodic roentgen examinations were made. There was no difference in the characteristics of the tumor during this time. In the five months' interval the tumor increased its size 40 per cent. It seemed that this growth rate was about the same as in 2 other instances where interval studies could be made (Cases 1 and 13). These findings suggest to us that reticulum cell sarcoma is a rather actively growing tumor. The duration of symptoms of an average of six and one-half months based on all cases also suggests a fairly aggressive tumor.

17. *Response to Irradiation.* All these cases (except Case 17 which is now receiving treatment) responded well both clinically and roentgenographically when given adequate treatment by irradiation. Repair in the roentgenogram was noted as early as one month and on an average of three months following treatment. The first evidence of improvement was disappearance of the periosteal mass, soon followed by re-establishment of the cortex, subsidence of the periosteal change, and finally by the appearance of a general increase in density of the lesion to a degree slightly greater than that of normal bone. This increase in density was due to the formation of linear

areas of bone resembling scar bone. The persistence of these changes has made it possible to identify readily the site of the treated tumor on roentgenograms taken six to ten years after therapy. In 2 instances where recurrence seemed apparent both clinically and roentgenographically the temporary reparative change was followed by bone destruction and the tumor tended to take on its original appearance (Cases 3 and 11).

Some estimation of the radiosensitivity and lethal tumor dose of roentgen radiation may be determined from a study of Cases 1 and 15. In the former, a seven and one-half year case with no evidence of disease, survival followed an estimated tumor dose of 2,200 r. In Case 15 multiple sections through the amputation specimen showed no viable tumor. This pathological examination was made several weeks following the completion of an estimated tumor dose of only 1,700 r. While the results in these 2 cases suggest a relatively radiosensitive tumor with a low cancericidal dose, most of these cases were estimated as having received a tissue dose in the range of 3,500 r.

*Summary.* Our findings indicate that primary reticulum cell sarcoma of bone is a radiosensitive tumor presenting constant features of single bone involvement, medullary origin, medullary and cortical bone destruction, ill defined borders and characteristic changes in the roentgenogram following roentgen therapy. The tumor tends to grow within the medullary portion of the bone with relatively small periosteal extension. Its osseous structure shows fairly regularly the presence of patchy areas of destruction often accompanied by areas of production with an absence of calcification in the periosteal portion of the tumor. Reticulum cell sarcoma tends to be ovoid in configuration when occurring at the ends of tubular bones and fusiform in the shaft and to be asymmetrical in position. Periosteal reaction is absent to moderate and when this feature is present it is of the lamellated type. There is a predilection for the long bones with over 40 per cent of the total

cases being located about the knee. In those tumors occurring about the knee, synovitis is not uncommon. In this group pathological fractures were present only in tumors of the mid-shaft of a long bone or in a vertebra. Reticulum cell sarcoma seems to be a moderately active tumor.

#### DIFFERENTIAL DIAGNOSIS

There was usually little difficulty in deciding that the roentgenographic diagnosis was tumor in these cases nor was there generally any problem in determining whether the process was a benign or malignant one. The essential problem was to state the type of malignant tumor. The tumor bearing the closest resemblance to reticulum cell sarcoma was osteogenic sarcoma. The separation of the more typical forms of sclerosing or osteolytic osteogenic sarcoma presented no great difficulty roentgenographically. It was in those osteogenic tumors of medullary origin in which the degree of production and destruction was nearly equal that the greatest problem arose. It was this type of tumor that most of these cases of reticulum cell sarcoma had been called. Osteogenic sarcoma in contrast to reticulum cell sarcoma is not a radiosensitive tumor and it shows no similar reparative change following therapy. Cortical destruction is thought to be less prominent and when present a cortical shadow is often noted. Osteogenic sarcoma shows less tendency to grow within the medullary portion of the bone or to show the fairly even patchy destruction and production in its osseous area, the internal pattern of osteogenic sarcoma being more disorganized, irregular and "wild." Periosteal reaction is a more prominent feature and the perpendicular type may be more frequently seen than the laminated type. There is a tendency for osteogenic sarcoma to form a larger periosteal mass and calcification of an irregular, amorphous type within this mass is more commonly seen. Synovitis is a less common feature in those osteogenic sarcomas occurring about the knee. Me-

tastasis to the chest is the common sequela of osteogenic sarcoma.

When reticulum cell sarcoma occurs in the shaft, Ewing's tumor may have to be considered in the differential diagnosis. Ewing's tumor generally falls in a younger age group. Periosteal reaction is a more constant and prominent feature in Ewing's tumor. The osseous structure of the tumor is usually purely destructive. While both are radiosensitive tumors, they apparently differ fundamentally as to radiocurability. In addition the roentgenographic response to treatment is quite dissimilar. Ewing's tumor in our experience often responds with the reappearance of nearly normal looking bone in the roentgenogram while reticulum cell sarcoma presents areas of scar bone. Ewing's tumor more frequently metastasizes to the chest and presents the somewhat unusual feature of metastasizing to other parts of the osseous system. The course of Ewing's tumor is relatively short and generally terminates fatally. Reticulum cell sarcoma, in contrast to this, runs a relatively benign and long course with not infrequent five year survivals. We have found, however, that when Ewing's tumor occurs in an older age group, its roentgenographic appearance tends to be more atypical and its roentgen diagnosis less dependable.

Metastatic cancer in bone may cause considerable trouble in differential diagnosis if it is of the mixed productive and destructive type. In cancer metastasis to bone, cortical destruction is less constantly seen. The osseous structure in metastasis does not usually present patchy areas of production and destruction. Periosteal reaction, when present, is probably more often of the perpendicular type. When a periosteal mass is seen, it more commonly has calcification within it. We have not noted synovitis in association with cancer metastasis to bones about the knee. The existence of a primary source is strong presumptive evidence that the process is a metastatic one and in cancer metastatic to bone there is a tendency to multiple bone

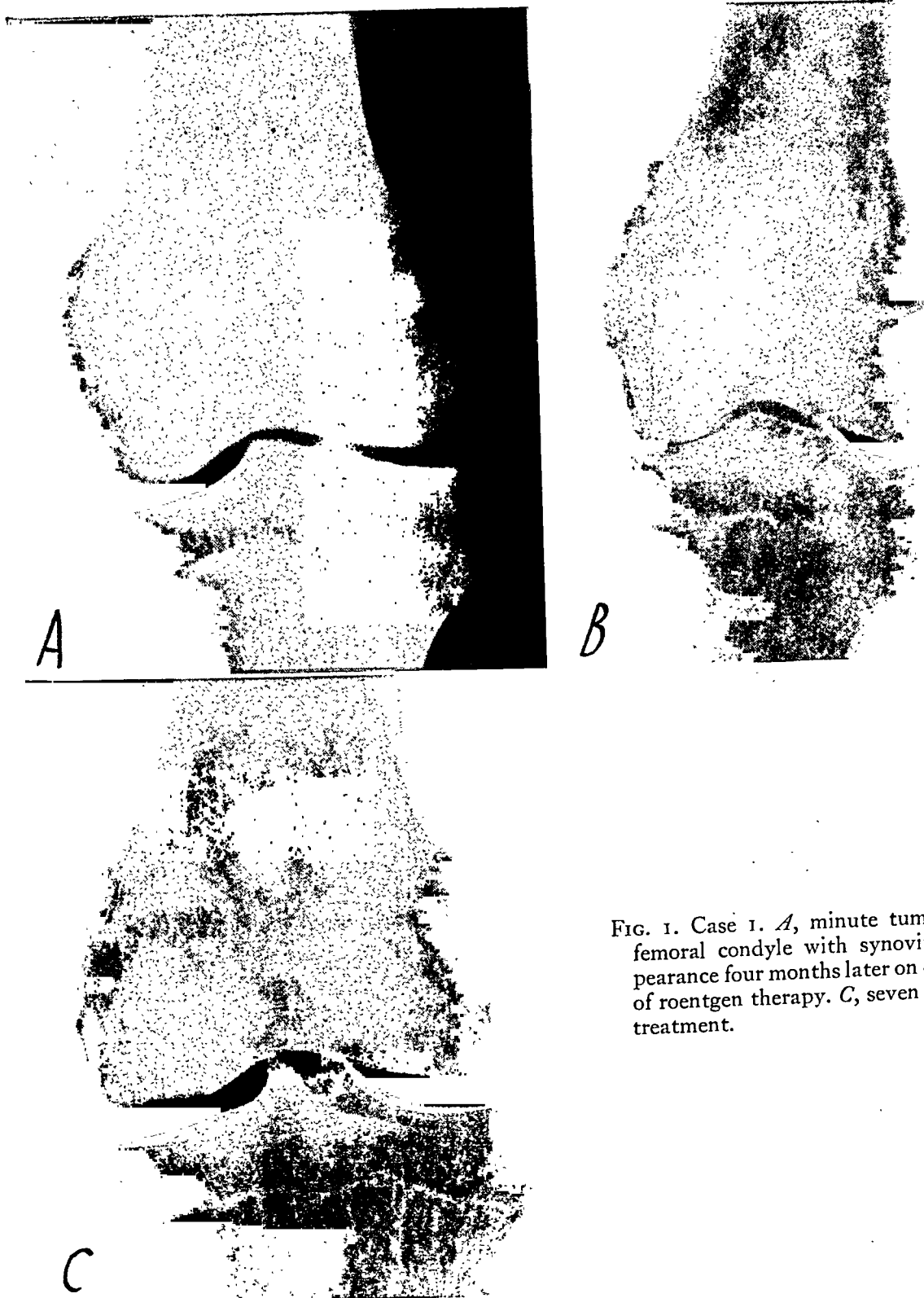


FIG. 1. Case 1. *A*, minute tumor, medial femoral condyle with synovitis. *B*, appearance four months later on completion of roentgen therapy. *C*, seven years after treatment.

involvement. Finally, response to irradiation is less favorable and such response as may be encountered lacks the more or less characteristic features noted in reticulum cell sarcoma.

In specific cases osteomyelitis, tubercu-

losis or rarer infections might be considered in the differential diagnosis of reticulum cell sarcoma. The bone changes of neuroblastoma and of the various forms of lymphoblastoma are to be differentiated from primary reticulum cell sarcoma of bone

chiefly on the multiplicity of bone involvement, the evidence of generalized disease, of changes in the blood and the clinical course.

It is well to remember that in the differential diagnosis of bone tumors their occurrence in bones other than the tubular ones tends to make diagnosis more difficult.

#### NOTES ON CLINICAL COURSE AND TREATMENT

It is not the purpose of this study to analyze the clinical aspects of reticulum cell sarcoma in detail but it seems essential for our purposes to mention some of the sig-

nificance of disease three years or more after treatment. There were 3 deaths in the series. One current case probably has active disease. In the remaining 3 current cases (Cases 14, 15 and 17) 1 is showing favorable response to irradiation, 1 is well with no evidence of disease following pre-operative irradiation and amputation, and 1 is in course of treatment. While Parker and Jackson considered amputation the treatment of choice, this procedure was carried out on only 1 of these cases. Otherwise irradiation was the treatment in all the rest except for 1 case in which irradiation was preceded by local excision (Case 7).

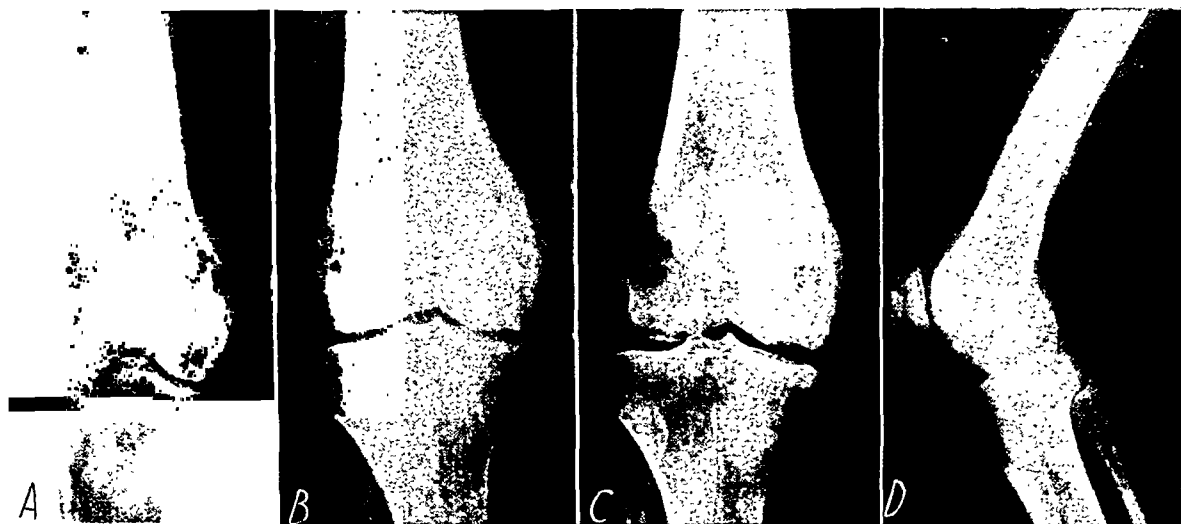


FIG. 2. Case 2. *A*, initial roentgenogram showing tumor involving entire medial femoral condyle. *B*, response one year after treatment. *C*, four and one-half years after treatment. This is the usual appearance after radiation therapy for reticulum cell sarcoma. *D*, lateral view showing synovitis accompanying tumor demonstrated in *A*.

nificant features in these cases. The age range was from thirteen to seventy-six years. We were unable to demonstrate any significant preponderance as to age group. In about half of the cases blood chemistry studies were made and showed values within normal limits. The clinical behavior of these patients appears to bear out the statement of Parker and Jackson to the effect that primary reticulum cell sarcoma runs a relatively benign course. Five patients are alive with no evidence of disease five years or more after treatment. Five patients are alive with no apparent evi-

#### CASE REPORTS

**CASE 1.** For eight months prior to admission to Memorial Hospital this male, aged sixteen, complained of pain and swelling of the left knee accompanied by slight weight loss and fatigue. Pain was unrelieved by rest. Three months before admission, examination elsewhere showed swelling of the left knee with evidence of free fluid and tenderness medially. A roentgenogram at this time (Fig. 1*A*) revealed only a slight rarefaction at the medial femoral condyle and a considerable degree of synovitis. A provisional diagnosis of tuberculosis was made and at operation "thick and cloudy" joint fluid and "soft necrotic areas" in the medial femoral



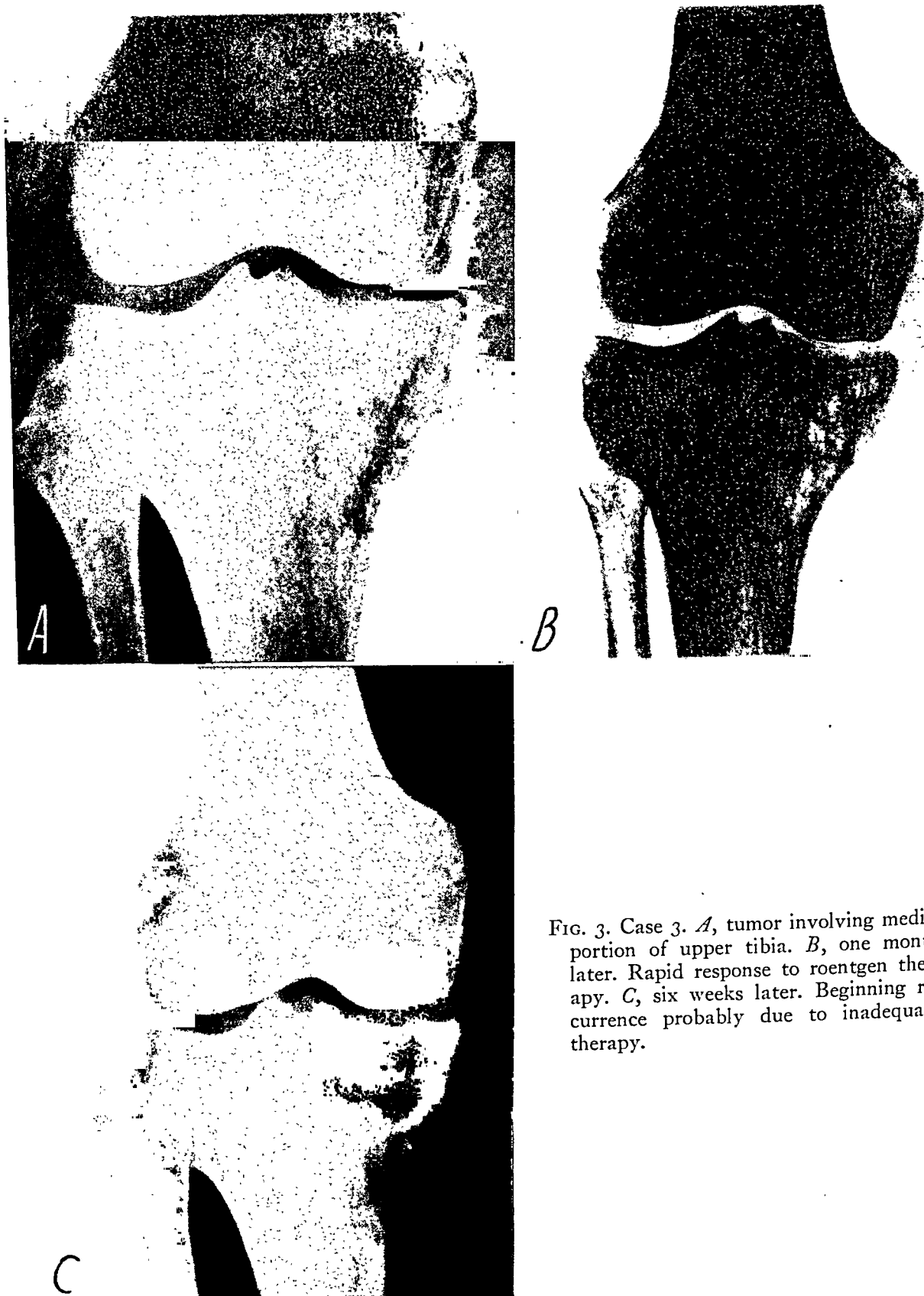


FIG. 3. Case 3. *A*, tumor involving medial portion of upper tibia. *B*, one month later. Rapid response to roentgen therapy. *C*, six weeks later. Beginning recurrence probably due to inadequate therapy.

condyle were described by the surgeon. Examination of the biopsy material showed no evidence of tumor but another biopsy was sug-

gested by the pathologist. The patient was treated by immobilization of the limb for two and one-half months with no improvement.

Further roentgen studies showed increase in the size of the rarefaction at the medial condyle and beginning periosteal reaction. A repeat biopsy was therefore done which showed reticulum cell sarcoma. He was then referred to Memorial Hospital and roentgen therapy was given to the left knee for an estimated tumor dose of 2,200 r (Fig. 1*B*). The clinical and roentgenographic course was favorable. The patient has now been observed for seven and one-half years since treatment and is well with no evidence of disease (Fig. 1*C*).

**CASE 2.** (Patient of Dr. Gray Twombly.) A female, aged twenty-five, complained of pain in the right knee following a fall. She was treated by plaster cylinder for thirteen weeks during which time there was continuous pain. Joint fluid was noted on removal of the plaster. Five months after onset of symptoms she was operated upon for removal of the internal semilunar cartilage. One month after operation a roentgenogram of the knee showed "osteoporosis of the lower end of the femur with elevation of the periosteum." Nine months after onset of symptoms she was referred to the Norwalk Tumor Clinic. Roentgenograms showed a tumor of the medial femoral condyle with accompanying synovitis (Fig. 2*A* and 2*D*). An aspiration biopsy showed reticulum cell sarcoma on smear and clot. Roentgen therapy was instituted, 3,000 r to a lateral and 2,700 r to a medial field (dose measured in air). There was complete relief of pain and she gained 23 pounds. Roentgenograms taken one year after treatment showed good healing (Fig. 2*B*). Except for occasional twinges of pain patient has remained symptom free and in excellent health three and one-half years after treatment. Recent roentgenograms show residual scarring such as is usually seen following treatment (Fig. 2*C*).

**CASE 3.** (Patient of Dr. Julian B. Herrmann.) The patient, a male, aged fifty-five, received radiation therapy to a tumor of the right upper tibia (Fig. 3*A*), biopsy of which had shown reticulum cell sarcoma. Exact amount of radiation given is not known but there was good initial response to treatment (Fig. 3*B*). There was rapid recurrence as evidenced by increased bone destruction on roentgenograms taken six weeks later (Fig. 3*C*). One year after treatment patient developed upper respiratory symptoms which did not respond to chemotherapy. A roentgenogram showed fluid in the right chest.



FIG. 4. Case 4. Reticulum cell sarcoma of upper tibia.

An abdominal mass was also discovered. Laparotomy was performed at another hospital and retroperitoneal lymphosarcoma was found. Roentgen therapy was instituted and patient's condition was reported as fair to good two months after this treatment.

**CASE 4.** For four months before being seen at Memorial Hospital, a male, aged seventeen, suffered with intermittent pain in the region of the right knee. Roentgenograms (Fig. 4) taken about two months before admission showed an extensive tumor of the proximal tibia. Several weeks before admission here the patient had two biopsies of the tibia. Submitted slides from the second biopsy have now been classified as reticulum cell sarcoma. On admission general physical condition was good. There was slight swelling over the upper tibia and the second biopsy wound was unhealed. Roentgen treatment was administered at another hospital in two series, one cycle before admission to Memorial Hospital and a second series six weeks later. Clinical and roentgen response was satisfactory and patient is alive and well over eleven years after the initial treatment.

**CASE 5.** For two years before being seen at Memorial Hospital, a female, aged eighteen,



FIG. 5. Case 5. Tumor involving lateral femoral condyle.

complained of intermittent pain and swelling of the right knee. Roentgenograms taken about one year prior to admission were reported as showing changes in the lateral femoral condyle. Biopsy just prior to entry to this hospital revealed reticulum cell sarcoma. Physical examination failed to demonstrate a palpable tumor but roentgenograms (Fig. 5) were interpreted as probable osteogenic sarcoma. Soon after admission roentgen therapy was given for an estimated tumor dose of 3,700 r. The patient had a good clinical and roentgenographic response and when last examined five and one-half years after treatment, she was in good health with no evidence of disease.

CASE 6. A female, aged twenty-seven, was seen at Memorial Hospital complaining of intermittent pain in the left knee accompanied by a limp for five months. Physical examination showed swelling of the left knee, probably associated with fluid, and roentgenograms showed a tumor of the upper tibia (Fig. 6). The patient was two and one-half months pregnant. Two days after admission an aspiration biopsy of the tibia was reported as "fits with reticulum cell sarcoma." She received heavy irradiation through three fields to the left upper tibia over a period of one month. She had good initial

response both clinically and roentgenographically. The patient was not followed at Memorial Hospital, but three years and two months after her roentgen treatment she was reported to be alive and well but showing late irradiation changes.

CASE 7. For two months before admission to Memorial Hospital, the patient, a female, aged thirteen, complained of swelling and pain in the right ankle. The pain was worse at night. Roentgenograms were interpreted elsewhere as osteomyelitis (Fig. 7). At operation a biopsy was taken which showed reticulum cell sarcoma. The patient was then referred to Memorial Hospital where a fibulectomy was done followed by roentgen treatment to the leg. The patient is now living and well with no evidence of disease three years since treatment.

CASE 8. For about six months before admission to Memorial Hospital, this male, aged fifty-three, complained of pain and swelling of the left arm. Roentgenograms showed a malignant process in the mid-shaft of the humerus (Fig. 8). Biopsy from the humerus was reported as primary tumor of bone, possibly reticulum



FIG. 6. Case 6. Extensive involvement of upper tibia.

cell sarcoma, and a second biopsy confirmed this diagnosis. He was then referred to Memorial Hospital. Physical examination revealed no peripheral nodes. There were findings in the chest of bilateral tuberculosis of advanced degree. Roentgen therapy was given to the humerus. Shortly after completion of this series patient sustained a pathological fracture. There was clinical improvement following therapy. A second series of roentgen treatments was given to the arm about a year and a half after the first. At this time the patient was readmitted to the hospital because of weight loss and a large abdominal mass which was thought to be liver. Treatment by radium element pack caused the mass to disappear. Twenty months after the first entry he was readmitted and was given 15 per cent skin erythema dose general body irradiation. During all this time the pulmonary tuberculosis progressed and a large cavity developed on the left side. He died at home of a massive pulmonary hemorrhage twenty-one months after first being seen.

CASE 9. (Patient of Dr. Alfred F. Hocker.) A



FIG. 7. Case 7. Lesion of distal third of fibula. There is a moderate sized soft parts tumor.



FIG. 8. Case 8. Mottled destruction of mid-shaft of humerus.

male, aged forty-four, fractured his left femur following a very slight trauma. The fracture had been preceded by a few weeks of pain in the left thigh. He was hospitalized and a cast applied but when the fracture failed to heal, he was transferred to a terminal home. Six months later (Fig. 9) he was admitted to another hospital where a biopsy of a large soft parts mass accompanying the bone tumor showed reticulum cell sarcoma. He was given roentgen therapy to four fields covering the entire femur for a total of 1,500 r (air dose) to each field.



FIG. 9. Case 9. Tumor of mid-shaft of femur with pathological fracture. Metal splint in place.

There was solid healing of the fracture and he has remained alive and well seven years.

CASE 10. During the year before entry to Memorial Hospital the patient, a male, aged sixty-three, noted a swelling over the lower right chest posteriorly. There was pain related to this swelling for two weeks. On admission, physical examination disclosed a mass over the right eighth rib posteriorly. There were no palpable nodes. Roentgenograms (Fig. 10) revealed bone destruction in the eighth rib posteriorly and an associated intrathoracic mass which was well circumscribed. Aspiration biopsy was reported as malignant tumor. At operation the mass was not considered to be resectable. A biopsy was taken and reported as probably reticulum cell sarcoma of bone. Roentgen

therapy was given with an estimated tumor dose of 3,500 r. Roentgenograms made following this treatment showed regeneration in the rib and disappearance of the tumor. The patient has remained well for three years with no evidence of disease.

CASE 11. A female, aged seventy-six, complained of pain in the left shoulder for one year before admission. A supraclavicular node excised one year previously had shown only hyperplastic changes. Nevertheless this had been treated by irradiation. Pain continued and

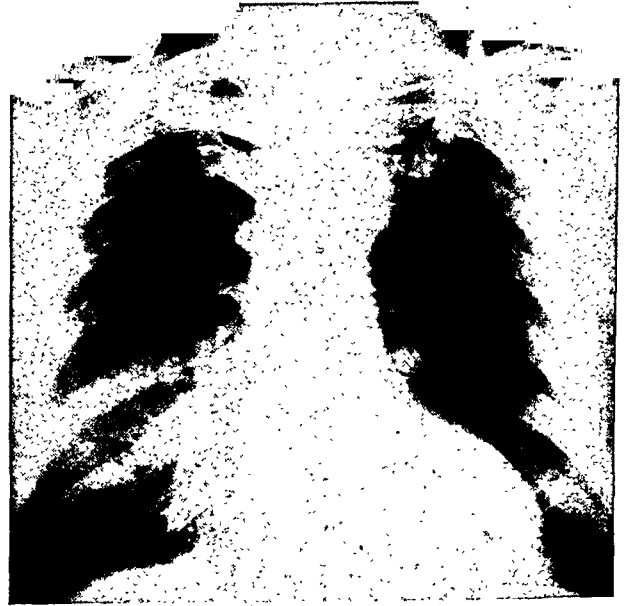


FIG. 10. Case 10. Tumor of right eighth rib posteriorly with extensive soft parts mass.

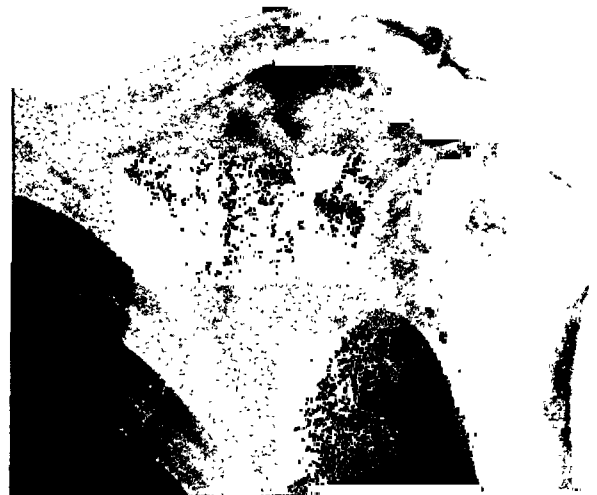


FIG. 11. Case 11. Lesion of spine and glenoid of scapula.

roentgenograms taken on admission (Fig. 11) showed a tumor of the scapula. There was an associated palpable mass. Biopsy of the scapula showed reticulum cell sarcoma. Following admission, treatment totalling 2,000 r (measured in air) was administered to the scapula. Several months before death there was evidence of fluid in the left chest and further bone destruction in the scapula suggesting recurrent disease. Twenty months after treatment the patient died at home.

CASE 12. For three months before admission this female, aged thirty-six, complained of pain in the neck with weakness and stiffness in the left arm. Physical examination showed tenderness over the mid-cervical spine with marked spasm. There was no adenopathy. Roentgenograms revealed pathological compression fracture of the fifth cervical body (Fig. 12). Aspiration biopsy under roentgenoscopic guidance was reported as showing radiosensitive malignant tumor, most likely reticulum cell sarcoma. Roentgen treatment was begun and patient received 2,000 r (measured in air) to two fields over a period of three weeks. There was good initial clinical and roentgenographic response. Two months after treatment she was feeling fine but she died suddenly at another

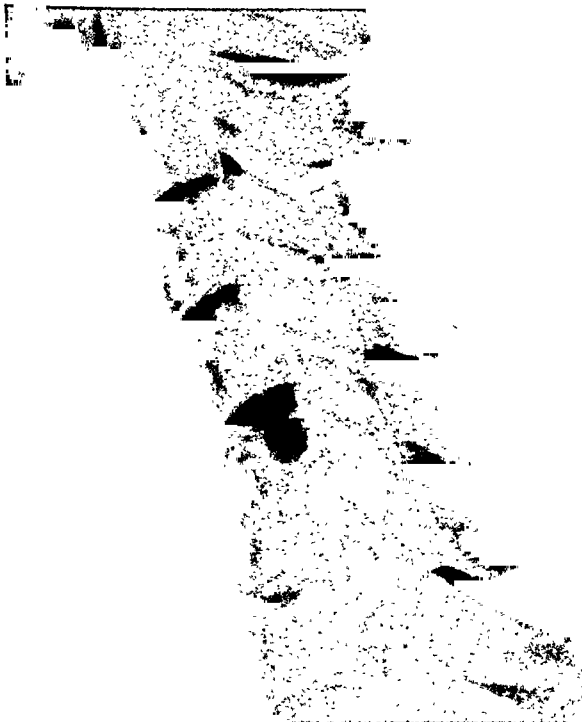


FIG. 12. Case 12. Involvement of fifth cervical vertebra.



FIG. 13. Case 13. Tumor of the fifth lumbar involving the body, pedicles, laminae, and transverse processes. There was complete repair of these structures following treatment with residual sclerosis and slight compression.

hospital three months later. We have been unable to ascertain the cause of death.

CASE 13. Following a fall ten months before entry to Memorial Hospital, a male, aged forty-eight, developed pain in the low back. Pain recurred after another fall seven and one-half months later. Roentgenograms made at this time (Fig. 13) were interpreted as fracture and the patient was put in a cast for six weeks. At the end of this time a biopsy was obtained surgically. This was reported as reticulum cell sarcoma and he was transferred to Memorial Hospital. Physical examination showed swelling over the last lumbar vertebra. There was no lymphadenopathy. Roentgen treatment was instituted. The patient improved and reparative changes were seen in the roentgenograms. He was well three years after treatment with no evidence of disease.

CASE 14. For two years before admission to Memorial Hospital this female, aged twenty-one, had noted a vague ache in her right arm. This had become more severe in the past six months and she finally consulted a physician.



FIG. 14. Case 14. Tumor in proximal third of humeral shaft with moderate sized periosteal mass.

Examination had shown a mass in the right arm and roentgenograms (Fig. 14) showed a fairly extensive area of production and destruction in the upper third of the humerus accompanied by moderate periosteal reaction. The submitted films were interpreted initially by us as chronic osteomyelitis as being most compatible with the relatively long history of two years. Repeat films at Memorial Hospital taken six weeks after the first examination showed rapid increase in the size of the process with change in appearance to a more destructive character and

with increased periosteal reaction of lamellated and perpendicular type. Two aspiration biopsies were not diagnostic, though the second showed malignant tumor insufficient to classify. An open biopsy was then performed and reported as reticulum cell sarcoma. Patient was four months pregnant on admission. Irradiation and Coley's toxins were chosen as the method of treatment. Twenty-four hours following the first injection of the toxins the patient spontaneously aborted a macerated fetus. Upon



FIG. 15. Case 15. Tumor in mid-tibial shaft.

recovery of the patient, the toxins were continued concurrently with roentgen therapy, the tumor receiving a dose of 3,200 r. A roentgenogram of the humerus taken one month following completion of therapy showed good initial healing and clinically the patient is symptom free. There has, however, been only two months follow-up.

**CASE 15.** A male, aged fifty-four, complained of pain and swelling of the right tibia for eight months. Three months later a roentgenogram of the tibia had shown an irregular area of destruction and production in the mid-shaft. This progressed and about one month prior to admission to Memorial Hospital a biopsy was taken elsewhere under a provisional diagnosis of abscess. Pyelograms revealed a non-functioning right kidney and the question arose as to whether a primary malignant bone tumor or cancer metastasis from a kidney tumor was the diagnosis. Roentgen therapy was administered to the tibia, a total of 1,700 r into the tumor being completed ten days before admission to Memorial Hospital. A roentgenogram (Fig. 15) at time of roentgen therapy showed a mottled area of production and destruction in the tibial shaft. Physical examination on admission revealed diffuse enlargement of the anterior mid-shaft of the right tibia but no discrete tumor mass. Biopsy scar was well healed. There was slight tenderness to deep pressure but patient complained of no pain at this time. The opinion of the roentgenologist was primary reticulum cell sarcoma of bone. Dr. Fred Stewart reviewed the submitted biopsy section and felt the tumor was primary reticulum cell sarcoma rather than cancer metastasis as had been diagnosed elsewhere. A low thigh amputation was done. No residual viable tumor was found on multiple sections through the tibia. Patient is well with no evidence of disease five months since operation.

**CASE 16.** A male, aged fourteen, had noted persistent pain in the left shoulder for eight months which did not respond to physiotherapy. Roentgenograms taken at another hospital showed a tumor of the left scapula which was interpreted as osteogenic sarcoma and he was referred to Memorial Hospital. On admission he was in good general condition. There was a firm tumor mass about 6 by 9 cm. in the region of the spine of the left scapula and there was limitation

of motion of the upper extremity. Roentgenograms showed a purely destructive tumor of the spine of the left scapula involving a small portion of the acromial epiphysis and accompanied by a large soft tissue mass. There was no periosteal reaction. Aspiration biopsy was reported as "Sarcoma: cellular, medium spindle and polyhedral cell." This slide has recently been reviewed by Dr. Fred Stewart and reclassified as reticulum cell sarcoma. Patient received roentgen therapy in two cycles over a period of four and one-half months for tumor doses of 3,540 r and 1,730 r. There was good clinical response to treatment and roentgenograms showed complete reformation of the scapular outline with only slight residual increase of density in the diseased area. Patient is alive and in good health ten years after treatment.

**CASE 17.** A male, aged thirty-seven, began to complain of pain and swelling of the right knee one year before admission to Memorial Hospital. He was seen at several different hospitals, at one of which a diagnosis of Paget's disease was made. No treatment was accepted by the patient and he was finally referred to Memorial Hospital. Heat and elevation of the leg had given some relief from pain and he had been able to continue his work as a printer during the year. On examination the right knee was swollen and tender to pressure. There was slight edema of the upper third of the leg. There was a small effusion and slight limitation of extension at the knee. Roentgenograms showed a predominantly productive tumor in the upper third of the right tibia associated with slight periosteal reaction and small periosteal soft parts mass. There was slight synovitis. Aspiration biopsy was inconclusive, hence an open biopsy was done and reported as reticulum cell sarcoma. Patient is now receiving radiation therapy.

#### SUMMARY AND CONCLUSIONS

1. The roentgenographic features of 17 proved cases of primary reticulum cell sarcoma of bone have been presented according to a method applicable to all bone tumors.
2. Certain general principles in the roentgen diagnosis of bone tumors have been briefly discussed.
3. Differential diagnosis has been briefly



mentioned from the roentgenographic standpoint.

4. Irradiation was the sole method of treatment in these cases except one where it was used in conjunction with local excision and in another where it preceded amputation.

5. Roentgenographically and clinically primary reticulum cell sarcoma of bone seems to be a radiosensitive tumor of relatively good prognosis with some evidence that it may be a radiocurable tumor.

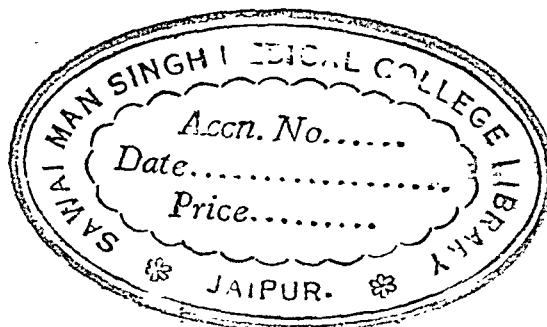
6. The roentgenographic appearance of reticulum cell sarcoma has been found to be

suggestive of the diagnosis and in certain instances to be almost characteristic.

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# POSTERIOR DISPLACEMENT OF LUMBAR VERTEBRAE

## CLASSIFICATION AND CRITERIA FOR DIAGNOSIS OF TRUE RETRODISPLACEMENT OF LUMBAR VERTEBRAE\*

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### INTRODUCTION

**P**OSTERIOR displacement of a lumbar vertebra, sometimes referred to as "reverse spondylolisthesis" or "spondylolisthesis posterior," consists of backward displacement of the cephalad vertebra in relation to the adjacent caudad vertebra. Our interest in this subject was first aroused by the comparative frequency with which this condition is encountered roentgenologically. Our curiosity was stimulated by Willis<sup>28</sup> contention that the roentgen appearance of backward displacement of the fifth lumbar vertebra is due to an optical illusion based on a discrepancy between the mid-sagittal diameters of the adjacent articular surfaces of the fifth lumbar and first sacral segments.

After further investigation it soon became apparent to us that, while in some cases we were indeed dealing with an illusion such as described by Willis,<sup>28</sup> there were other cases which we thought represented true instances of subluxation and were based on the existence of pathological conditions and were not due to faulty technique or anatomical variations. When our study of this problem was begun we did not possess sufficient criteria with which we could accurately determine whether our suspected cases and those cases reported in the literature were actually true instances of retrodisplacement. The purposes of this study were (1) to ascertain whether or not the condition of posterior displacement of the fifth lumbar vertebra on the sacrum actually exists and, if it does, what anatomical factors are important for consideration; (2) to determine what factors, anatomical, pathological, and/or technical, influence the

roentgen appearance of the lumbar vertebrae and sacrum; (3) to determine the roentgen criteria of true posterior displacement of lumbar vertebrae.

### REVIEW OF LITERATURE

Although we found the condition of backward displacement of lumbar vertebrae to be more frequent than heretofore supposed, the paucity of reports on this subject is indeed striking. What little has found its way into the medical literature is often confusing and contradictory, and one is at once impressed with the feeling that the subject warrants a great deal of further study and clarification. While Friedl<sup>7</sup> and Junghanns<sup>12</sup> feel that posterior displacement of the fifth lumbar vertebra is a rare condition, the reports of Knuttson<sup>15</sup> and Johnson<sup>11</sup> lend weight to our contention that the condition is not uncommon.

The earliest reports concerning dislocations of lumbar vertebrae include an article by Brailsford<sup>1</sup> in 1929 in which he lists the causes of vertebral dislocations under four headings: (1) congenital malformations; (2) chondro-osteodystrophy; (3) trauma; (4) disease processes. Brailsford describes a case of tuberculosis of the spine in which there was backward subluxation of the fourth lumbar vertebra on the fifth lumbar vertebra. Hibbs and Swift<sup>10</sup> in the same year recognized the existence of the condition of backward displacement of the fifth lumbar vertebra on the sacrum and claimed that this condition is more likely to occur in vertebra whose articular facets are of the anteroposterior type, the facets facing laterally and medially. Such articulations, they believe, permit greater mobility be-

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tween the fifth lumbar vertebra and the sacrum.

Junghanns<sup>12</sup> in 1931 classified cases of vertebral displacement into three groups: (1) true spondylolisthesis; (2) pseudo-spondylolisthesis; (3) posterior displacement. He reports 7 cases of backward displacement of lumbar vertebrae, 6 of which involve the second lumbar, and in 1 case, involves the first lumbar vertebra. Junghanns<sup>12</sup> visualizes two possible mechanisms in the production of posterior subluxation: (1) either by trauma or by degeneration the disc narrows, resulting in approximation of the adjacent vertebral bodies with backward displacement of the cephalad vertebra. The inferior articular facets of the vertebra above glide backward and downward on the superior articular facets of the caudad vertebra. (2) Traumatic tearing of the capsules of the apophyseal joints, resulting in unstable and hypermobile joints, can eventually give rise to degeneration of the disc. This, in turn, may lead to abnormal movements in the intervertebral disc regions and retrodisplacement. In one of his cases, Junghanns emphasizes trauma as a probable cause of posterior displacement based on the discovery of central herniations of the vertebrae.

Schmorl<sup>20</sup> in 1932 reported 9 cases of posterior slipping, 8 of which occurred at the second lumbar level and 1 at the first lumbar level. He stresses and calls attention to, as one of the roentgen signs of posterior displacement, overlapping (in the anteroposterior axis) of the superior and inferior articular processes. In these cases he also describes such findings as narrowing of the intervening disc and subarticular sclerosis, the latter resulting from constant irritation of movement. He contends that the primary cause of backward displacement is narrowing of a disc produced either by trauma or degeneration. In some cases he finds herniation of the disc into the spongiosa of the vertebrae, and thus he believes that trauma may have played a role in some of these cases. He stresses the fact that as a consequence of narrowing of the

disc, hypermobility of the adjacent vertebrae occurs and eventually causes laxity of the apophyseal joints. His cases occurred in the upper lumbar area where normally the articular facet surfaces are supposed to incline downward and backward. There is considerable doubt as to whether infection can be a factor in the production of posterior displacement of vertebrae, but Schmorl imagines that such a possibility exists, as for example, in infectious spondylitis due to typhoid fever.

Schmorl<sup>20</sup> mentions the observations of Gütztz,<sup>9</sup> who noted that straightening of the spine occurs above the level of a vertebral displacement, and that similar straightening occurs in cases where there is disappearance of a single disc. Schmorl also refers to a case report by Mosenthal in which the first lumbar vertebra was displaced posteriorly. Waindruch and Kozeky<sup>26</sup> have described what is probably the only congenital case of posterior dislocation in the literature; the fifth lumbar vertebra slid from the level of the sacrum to lie adjacent to the posterior surface of the upper third of the sacrum.

The importance of narrowing of the intervertebral disc as a cause of backward displacement of vertebrae is stressed by Williams and Yglesias.<sup>27</sup> In 1934 Ferguson,<sup>5</sup> in his discussion of lumbosacral anomalies, mentions and recognizes the condition of backward displacement of the fifth lumbar vertebra on the sacrum. Ferguson<sup>4</sup> believes this condition is commonly associated with symptoms and attributes the displacement in this region to hypermobile lumbosacral articulations. In the same year Johnson<sup>11</sup> reported that backward displacement is a common back condition and that it represents about 10 per cent of all cases where lumbosacral pathology is suspected. He attributes the condition to disc and congenital malformations and reports a series of 12 cases, explaining the symptoms on the basis of narrowing of the intervertebral foramina. Other factors, such as the intervertebral space, lumbosacral angle, and congenital malformations,

he says, are inconstant. Johnson<sup>11</sup> was unsuccessful in an attempt to reproduce on roentgenograms evidence of backward displacement of vertebrae by employing mounted anatomical specimens and altering their position in relation to the central ray of the roentgen tube. Thus, he thinks that this condition is not due to faulty roentgen technique, but rather represents a definite clinical and pathological entity. Johnson, however, used a rigid anatomical specimen in which he failed to simulate conditions in vivo, where rotation and lateral flexion usually occur with the patient lying on his side. A. DeForest Smith,<sup>23</sup> in 1934, in a period of approximately six and one-half years at the Clinic of the New York Orthopedic Hospital and in his private practice, discovered only 56 cases of backward displacement. Smith dwells on the importance of the structure and form of the articular facets as a primary cause of posterior displacement of the fifth lumbar vertebra. He believes that trauma plays only a secondary role and then only if a certain anatomical set-up is present. He states that in most of his cases the articular facets in the lumbosacral region face anteriorly and posteriorly, and he expresses the view that such joints are less stable and permit easier displacement. Smith operated on a number of these cases and found greater mobility in the lumbosacral joints than is normal in this region.

Willis<sup>28</sup> was the first to draw attention to anatomical variations in the posterior border of the first sacral segment. As a result of his observations on sacra and fifth lumbar vertebrae of 50 skeletons obtained from the Hammond Museum, he claims that backward displacement of the fifth lumbar vertebra represents an optical illusion. He bases his contention on a discrepancy in the anteroposterior diameters of the adjacent surfaces of the fifth lumbar and first sacral segments. Measurements of these anatomical specimens revealed that only 17 out of 50 showed equal anteroposterior diameters, while in 33 the anteroposterior diameter of the superior

sacral surface was less than that of the inferior surface of the fifth lumbar vertebra. In the latter group most of the posterior borders of the superior sacrum were straight or convex, while in a few instances there was concavity of the posterior borders. Willis believes that the sacra with smaller anteroposterior diameters are responsible for the illusion of posterior displacement of the fifth lumbar vertebra. If this be true, we feel one should encounter a greater number of such cases, since we made measurements on roentgenograms of 100 supposedly normal individuals and found that 80 per cent of these patients showed the anteroposterior diameter of the superior sacral surface to be less than the adjacent surface of the fifth lumbar vertebra. Willis contends further that posterior displacement of the fifth lumbar vertebra cannot occur because it would have to travel "uphill." While it is true that we find more cases in the upper lumbar region than in the lower lumbar area due to the fact that the line of stress in the former is naturally downward and backward, we nevertheless found some cases at the lumbosacral junction where the lumbosacral angle was diminished or reversed, no longer making it necessary for the fifth lumbar vertebra to travel "uphill."

de Veer<sup>25</sup> applies the term "spondylolisthesis posterior" to the condition of backward displacement. In his case there is unmistakable backward displacement of the fifth lumbar vertebra as the anterior sacral border was found to project 1 cm. forward. de Veer thinks this condition is due to degeneration of the disc as well as loosening of the ligamentary apparatus. He adds that frequent small traumata might be instrumental in producing the condition, and he agrees with Junghanns that the arrangement of the apophyseal joints is an important factor. de Veer mentions Müller's<sup>19</sup> report of 2 cases due to degeneration of the discs, loosening of the ligaments and marked lordosis of the spine. In 1 of the cases three lumbar vertebrae were displaced backward in "staircase" fashion,

a description which arouses skepticism, because in our work we observe that such "staircase" phenomena are the result of faulty roentgen technique and do not represent pathological entities. We noted that "staircasing" is due to rotation of the vertebrae.

Another report in 1935 by Friedl<sup>7</sup> emphasizes weakening of the intervertebral disc as an important factor in backward displacement. He attaches the same importance to the condition of backward displacement as to anterior displacement. He reiterates that retrodisplacement is more common in the upper lumbar region than in the lower lumbar region, but he states that if the posterior portion of the lumbosacral disc degenerates more than the anterior portion and if the sacrum happens to be more horizontal than normal, posterior displacement of the fifth lumbar vertebra can occur.

Though Kleinberg and Burman<sup>13</sup> wish to consider their cases as atypical spondylolisthesis, we prefer to consider them as that of posterior slipping. The cephalad vertebrae are displaced posteriorly and contain defects in their posterior portions. Their examples fulfill our criteria for posterior slipping due to trauma—probably the only cases on record in which the evidence is so convincing of traumatic origin. Retrodisplacement instead of anterior slipping occurred due to the line of gravity pointing downward and posteriorly in contrast with normal conditions at the lumbosacral joint (or below the level of the third lumbar vertebra where the force is directed downward and forward). Lyon<sup>16</sup> cites a case of posterior displacement in the upper lumbar region, and he stresses the prominent role played by the posterior longitudinal ligaments in such a condition. Lyon also recognizes the importance of narrowing the intervertebral foramina in the ventrodorsal direction. Breck<sup>3</sup> believes that backward displacement of the fifth lumbar vertebra is due to narrowing of the disc and posterior inclination of the articular facets.

Comprehensive work on the subjects of

disc degeneration and retrodisplacement has been done by Knutsson.<sup>14,15</sup> Disc degeneration causes abnormal movements between vertebrae and is the prime underlying etiological factor of posterior displacement. The roentgen signs of disc degeneration are therefore worthy of particular consideration in the subject under discussion. He lists the signs of disc degeneration as follows: (1) parallel displacement of vertebrae (retrodisplacement included); (2) narrowing of intervertebral space; (3) reactive changes in vertebral bodies; (4) vacuum phenomenon (Magnusson<sup>17</sup>); (5) abnormal locations of vertebrae in relation to each other; (6) abnormal motion. He advocates functional tests for stability of the disc by supplementing roentgenograms in the recumbent position with upright ones taken with the spine in flexion and extension. Such studies have shown that backward displacement is more frequent than previously appreciated or suspected. Furthermore, Knutsson is able to detect cases of so-called "incipient disc degeneration" by demonstrating parallel displacement without any other anatomical evidence of disc degeneration. He states that retrodisplacement is a manifestation of instability.

According to Fick<sup>6</sup> and Strasser,<sup>24</sup> parallel displacement does not occur between vertebrae in a normal spine. If displacement between vertebrae occurs, it signifies disc degeneration. Severin<sup>21</sup> has similarly reported retrodisplacement of vertebrae in 50 per cent of cases of disc degeneration.

#### ANATOMY

Anatomical variations in the lumbar spine, particularly at the lumbosacral joint, are frequent in occurrence. Roentgenographically one may encounter real or apparent abnormalities in this region, and unless one is constantly on his guard, errors in interpretation may result.

Although the normal lumbar curve is lordotic, wide variations in the lumbar curvature are seen both clinically and roentgenologically. The center of gravity of the body may be represented by a line which passes through the center of the body of the third lumbar vertebra. In the upper lumbar region, therefore, the stress is

downward and backward, while in the lower lumbar region the stress is downward and forward. The lumbar region of the spine permits a great deal of motion in forward, backward and lateral bending of the trunk, motion of vertebrae occurring at the intervertebral discs and in the apophyseal joints. These movable segments of the spine are supported by numerous ligaments which tend to stabilize the spinal column. The intervertebral fibrocartilage, which forms a tough covering of the disc, joins the inferior and superior surfaces of adjacent vertebral bodies, while the strong longitudinal spinal ligaments lend support to the vertebral bodies anteriorly and posteriorly. The posterior arch of the spinal column is supported by the ligamentum flavum and the infra- and supraspinous ligaments, while the apophyseal joints are stabilized by their joint capsules and the intrinsic muscles of the spine. The articular facets of the lumbar vertebrae have concave-convex surfaces—the superior facets being concave, and the inferior facets convex. Generally the facets in the lumbar region face medially and laterally, but in the lumbosacral region the articular facets quite frequently face anteriorly and posteriorly. The planes of the articular facets in the upper lumbar region tilt backward and downward, most authors claim, while in our experience the planes are more or less vertical.

The bodies of the lumbar vertebrae increase in size from the first to the last lumbar, and the pedicles tend to become shorter and broader as they approach the sacrum. Usually the body of the fifth lumbar vertebra exhibits flaring or skirting at the posterior-inferior margin. This skirting tends to widen the anteroposterior diameter of the body of the vertebra in relation to the corresponding diameter of the superior surface of the first sacral segment, the effect being exaggerated when slight rotation of these vertebrae is present. Though the posterior margin of the bodies of the lumbar vertebrae is usually slightly concave, the posterior margin of the body of the first sacral vertebra is most frequently convex or straight. Occasionally, however, the posterior border of the first sacral vertebra is found to be concave.

The intervertebral discs in the lumbar region of the spine are larger and thicker than those in the dorsal or cervical regions and tend to increase in size as they approach the sacrum. The height of the intervertebral discs in the lumbar vertebrae is greater anteriorly than posteriorly.

This is particularly true at the lumbosacral interspace.

#### CLASSIFICATION

Following preliminary study of the literature and our roentgenograms it soon became apparent that not all cases of backward displacement were alike or due to the same factors. When some of these patients were re-examined roentgenologically backward displacement persisted as a constant finding in certain instances while in others signs of backward displacement vanished. In our attempt to separate the various types of cases of backward displacement, we formulated the following classification:

- I. True backward displacement of lumbar vertebrae.
  - A. Due to degenerative processes.
  - B. Due to disease.
  - C. Due to trauma.
  - D. Due to congenital anomalies
- II. Apparent backward displacement of lumbar vertebrae.
  - A. Due to technical factors.
  - B. Due to anatomical variations.

#### I. *True Backward Displacement of Lumbar Vertebrae.*

A. *Due to degenerative processes.* We believe that the greatest majority of true cases of retrodisplacement of vertebrae are primarily the result of degeneration of the intervertebral disc. Degeneration of the disc results in instability (Knutsson<sup>15</sup>) and relaxation of the longitudinal ligaments (Lyon<sup>16</sup>), permitting greater movement between the vertebrae which gives rise to stretching of the capsules of the apophyseal joints and ultimately retrodisplacement. Instability, according to Knutsson,<sup>15</sup> is usually accompanied by sclerotic changes and lipping of the articular borders as late signs, but parallel displacement can represent an early sign of disc degeneration, even though no roentgen evidence of narrowing of the disc is present. Degeneration of the intervertebral disc probably occurs as part of systemic degenerative changes. The disc is one of the first structures to suffer such changes because of the constant stress and

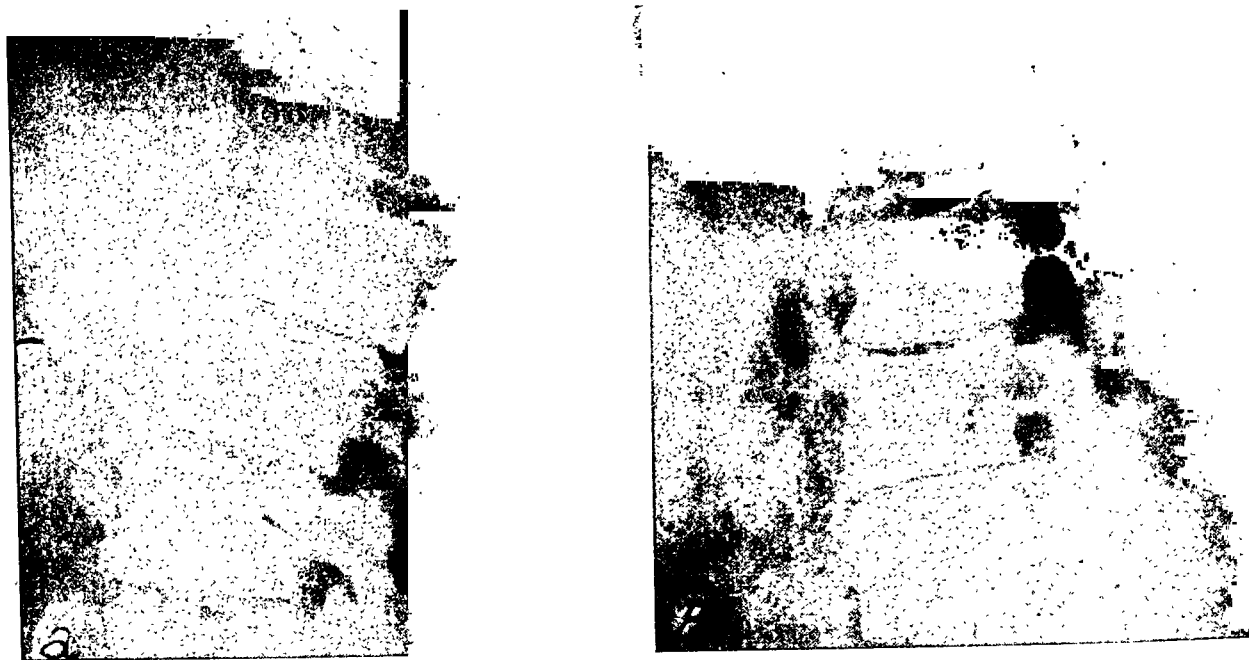


FIG. 1. *a.* Mr. C. H., aged sixty. Upright lateral roentgenogram in flexion shows posterior displacement of first lumbar vertebra on the second lumbar vertebra. Note marked narrowing of intervertebral space, vertical and anteroposterior narrowing of the intervertebral foramina resulting in "hour-glass" deformity of these structures, and overlapping of articular processes. *b.* In hyperextension there is increased retrodisplacement.

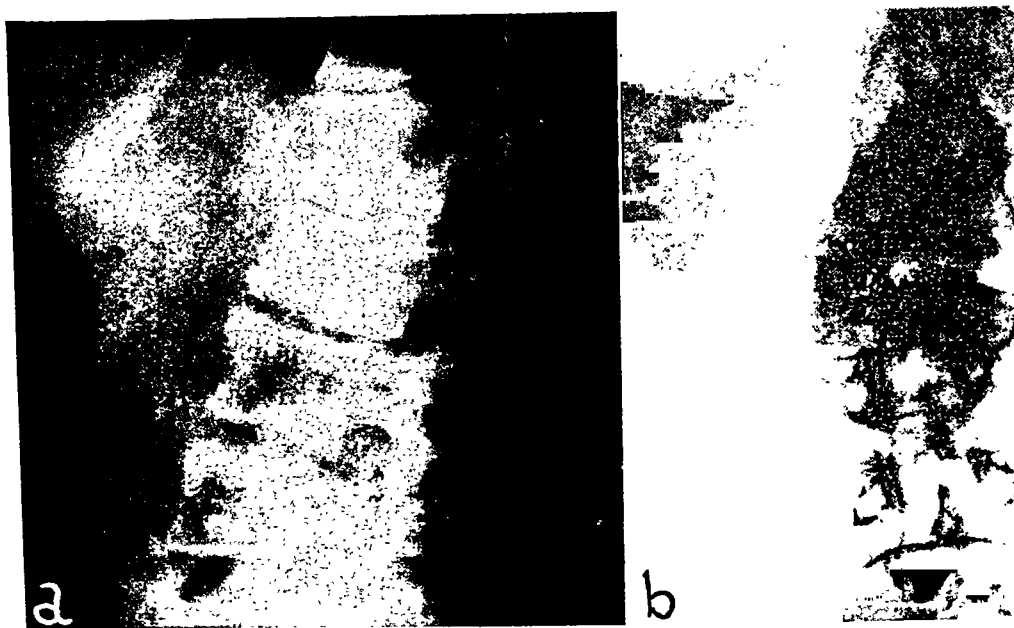


FIG. 2. *a.* Mr. R. H., aged forty-four. Lateral roentgenogram showing backward displacement of second lumbar vertebra on third lumbar vertebra with marked narrowing of the intervening space. Note reactive changes including subarticular sclerosis, lipping, spur formation, etc., and "hour-glass" appearance of the intervertebral foramina. Note characteristic "step-ladder" appearance of the other lumbar vertebrae due to rotation. *b.* Anteroposterior projection reveals rotary and lateral scoliosis of the lumbar spine which accounts for "step-ladder" effect noted in *a.*

strain and frequent traumata to which they are subjected. True cases of retrodisplacement occur more frequently in the upper lumbar region (Fig. 1, *a* and *b*, 2, *a* and *b*) than in the lower lumbar region (Fig. 3, 4, 5, 6, and 7, *a*, *b*, *c*) because the upper half of the lumbar spine—above the level of the third lumbar vertebra—inclines backward in relation to the center of gravity. In the lower lumbar spine, on the other hand, the stress is downward and forward, while the articular facets approach or lie in the vertical plane. Since the lumbosacral junction slants forward and downward, there is, of course, a greater tendency to anterior displacement in this region. Fewer true cases of backward displacement occur in this region in spite of the fact that the greatest incidence of disc involvement occurs here.

An important sign of retrodisplacement is what we have called the "hour-glass" appearance of the intervertebral foramina. The narrowing is, for the most part, in the ventrodorsal axis. The distance between the posteroinferior border of the cephalad vertebra and the anterior border of the superior articular process of the caudad vertebra is reduced by the displacement and produces an "hour-glass" appearance.



FIG. 4. Mr. W. B., aged fifty. Lateral roentgenogram reveals posterior displacement of fourth lumbar vertebra on the fifth. Reactive changes are quite marked and the intervertebral foramina show typical "hour-glass" appearance. Widening of apophyseal joints (facets of anteroposterior type) well demonstrated (arrows).



FIG. 3. Mrs. M. K., aged fifty-five. Lateral projection of lower lumbar vertebrae shows degeneration of anterior portion of fourth lumbar disc, with early reactive changes and slight retrodisplacement. The intervertebral foramina are narrowed.

If the intervertebral space is reduced in height then narrowing in the vertical axis also occurs. One must differentiate such "hour-glass" constriction found in true backward slipping from encroachment of these foramina by osteophyte or spur formation at the posteroinferior margin of the cephalad vertebral body.

In 2 of our patients with posterior displacement at the lumbosacral junction (Fig. 7, *a*, *b*, and *c*) the lumbosacral angle was actually reversed and the intervening discs showed thinning. Friedl<sup>7</sup> states that if the posterior portion of the fifth lumbar intervertebral disc degenerates more than the anterior portion and if the sacrum is more horizontal than usual, posterior displacement can occur as shown in our patients (Fig. 7 *a*, *b* and *c*). Degeneration of the articular cartilage of the apophyseal





FIG. 5. Mr. J. K., aged forty-five. Lateral roentgenogram of lumbosacral junction shows slight narrowing of the posterior portion of the intervertebral disc and slight retrodisplacement of the fifth lumbar demonstrated by widening of the apophyseal joint space (indicated by arrows).

joints could initiate the process of backward displacement only if, as a result of this degeneration, there occurred subsequently stretching of the ligaments, hypermobility of adjacent vertebrae, and ultimate degeneration of the intervening disc (Junghanns<sup>12</sup>).

**B. Due to trauma.** Sudden, severe trauma can produce backward displacement of vertebrae. Any severe trauma or injury to the disc, the osseous structures of the spine, the apophyseal articulations, or ligaments supporting the vertebrae can ultimately result either primarily or secondarily in backward displacement. In 2 of our patients the trauma was of sufficient severity to be considered as the probable etiological factor. Mr. H. E. fell and forcibly struck his back against the sharp edge of the stairs. He developed typical symptoms of a disc syndrome in the lumbosacral region and was disabled for several months. Roentgen examination (Fig. 7a) shows narrowing of the intervertebral space with

retrodisplacement. The other patient, Mr. D. R., slipped while working in a boxcar and his back struck the sharp edge of the boxcar platform, following which he developed severe low back pains and sciatica. The roentgenograms (Fig. 7, b and c) reveal a narrowed interspace and retrodisplacement. At operation a ruptured disc was found at the lumbosacral junction.

Other examples of retrodisplacement of lumbar vertebrae probably due to trauma are the cases described by Kleinberg and Burman<sup>13</sup> who considered their cases as atypical spondylolisthesis. The upper vertebral column is displaced posteriorly on the inferior column and the retrodisplaced vertebrae show dissolution in their posterior portions.

**C. Due to disease.** Brailsford<sup>1</sup> describes a case of retrodisplacement which occurred



FIG. 6. Mr. R. W., aged forty. Lateral roentgenogram showing backward displacement of the fifth lumbar vertebra on the sacrum. Note narrowing of interspace posteriorly, narrowing of intervertebral foramina, widening of apophyseal joints (arrows). The apophyseal facets are of the anteroposterior type, the joint width being accurately demonstrated, therefore, in the lateral view. (Oblique roentgenograms failed to demonstrate the true width of these joints.)

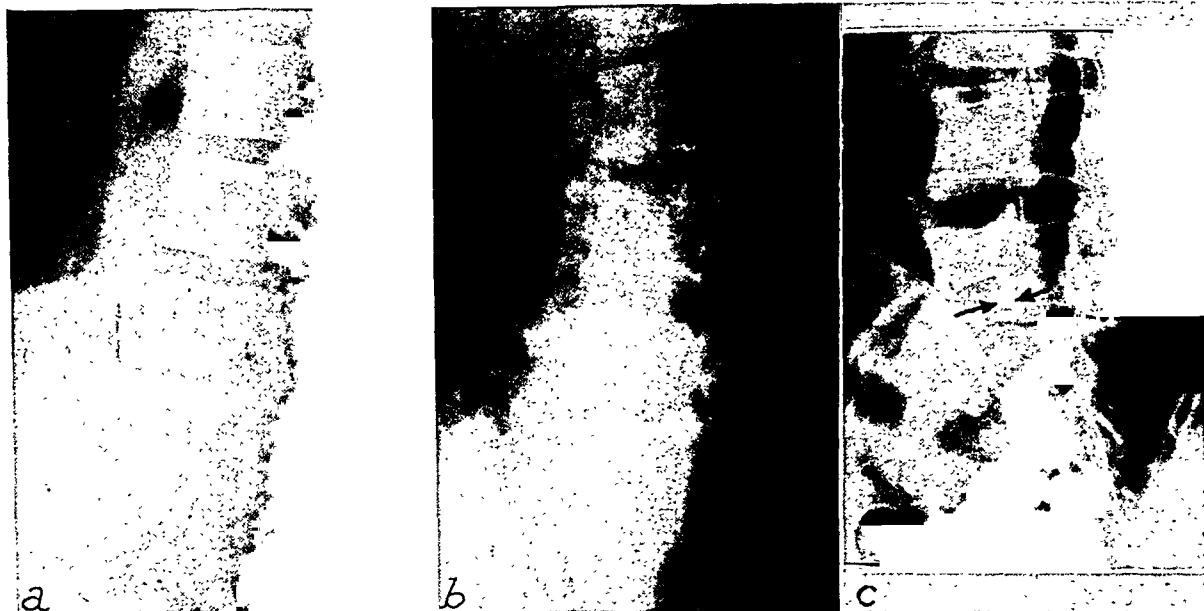


FIG. 7. *a*. Mr. H. E., aged thirty-seven, fell down some stairs and struck his back against edge of steps in May, 1945. Patient developed backache and sciatica on the left side and had been disabled for several months. Lateral roentgenogram demonstrates true backward displacement (overlapping of anterior and posterior margins of the vertebrae) with narrowing of intervertebral space at the lumbosacral junction. The intervertebral foramina are narrowed and subarticular sclerosis is visible. The lumbosacral angle is approximately  $-5$  degrees. The lumbar curve is slightly kyphotic. (Film measurements: anteroposterior diameter of inferior surface of fifth lumbar is 46 mm.; anteroposterior diameter of superior surface of sacrum is 42 mm.)

*b* and *c*. Mr. D. R., aged thirty-four, fell off boxcar and injured his back on November 27, 1939. Patient developed disabling back pain with sciatic radiation. Lateral roentgenogram (September 30, 1941) shows posterior subluxation of the fifth lumbar on the sacrum. The lumbar curve is kyphotic, the fifth lumbar intervertebral disc is narrowed, and the lumbosacral angle is  $-5$  degrees. Oblique projection shows definite widening of the apophyseal joint space (arrows). (Roentgen measurements: anteroposterior diameter of inferior surface of fifth lumbar is 49 mm.; anteroposterior diameter of superior surface of sacrum is 44 mm. Though a discrepancy between these anteroposterior diameters exists as in *a*, our criteria for true backward displacement are fulfilled.)

in tuberculosis of the spine. Other diseases of etiological significance which have been mentioned are syphilis, osteomyelitis, primary and secondary bone tumors, etc. Theoretically, conditions such as senile osteoporosis and osteomalacia might be of etiological importance.

*D. Due to congenital anomalies.* So far as we have been able to ascertain, there has only been one report of retrodisplacement of congenital origin. This case which was reported by Waindruch and Korezky<sup>26</sup> showed the fifth lumbar vertebra to be displaced posteriorly on the sacrum so that it slipped caudad and posteriorly to the level of the upper third of the sacrum. Though proof might be lacking, there is little reason to doubt that congenital relaxation of the ligamentous structures of the spine could be

of etiological significance in some cases. One cannot deny that congenital factors might be responsible for early degenerative processes involving the disc structure. Abnormal architecture of the spine attributable to congenital anomalies is undoubtedly responsible in some instances of backward displacement. Articular facets facing anteriorly and posteriorly in the lumbosacral region probably do not form as stable a joint as those facing laterally and medially. Asymmetrical arrangement of the facets might likewise result in an unstable lumbosacral joint.

## II. Apparent Backward Displacement of Lumbar Vertebrae.

Many cases originally designated by us as representing backward displacement,

upon critical review and reconsideration, were discovered either to represent errors in technique or to be due to anatomical variations, or both. Perhaps the commonest of all factors responsible for the appearance of backward displacement on roentgenograms is faulty technique. So common are the findings of backward displacement due to faulty technique, that it is our belief that numerous cases reported in the literature do not represent true instances of retrodisplacement. Many of the illustrations we have examined during our search of the literature are not too impressive and have not fulfilled our criteria for such a diagnosis.

Technical factors which can lead to errors in interpretation are faulty positioning of the patient on the roentgen table by disregarding the factors of rotation and sagging of the lumbar spine, incorrect alignment of the central ray to the structures in question, short target-to-film distance, etc. Anatomical and pathological factors which can account for apparent backward displacement are discrepancies between the mid-sagittal diameters of the fifth lumbar and first sacral segments, flaring or skirting of the posteroinferior border of the fifth or last lumbar vertebra, hypertrophic lipping of the posteroinferior margin of the cephalad vertebral body, tapering of the vertebral bodies, sacralization of the last lumbar vertebra and bevelled posterosuperior margin of the sacrum.

It is difficult to define exactly what constitutes a complete roentgen examination of the lumbosacral spine. As is true in gastrointestinal investigations, the roentgen findings in the lumbosacral spine will be directly proportional to the number of properly exposed films. The usual routine recumbent anteroposterior and lateral projections of the lumbosacral spine, in the light of recent advances in technique and interpretation, can no longer be construed to represent, even in the slightest, an adequate roentgen study. Examination in the upright position is strongly recommended.

In roentgen studies of the lumbosacral spine Knutsson has recently advocated and

demonstrated the value of examining patients in forward and backward bending in testing for instability of the intervertebral disc and in the demonstration of hypermobility. Oblique projections are indispensable for visualization of the posterior portions of the vertebrae and the apophyseal joints. The value of the oblique projections is limited, however, so far as the apophyseal joints are concerned. The true width of the joints is of primary importance in the condition of retrodisplacement and this joint space is not accurately represented in oblique projections in most instances because of the variability of the planes of the articular facets. Should backward subluxation occur in patients in whom the facets face laterally and medially, widening of the apophyseal joint space would not be revealed by the oblique projections. As a matter of fact, there is actually no increase in the width of the joint space in such instances. The only demonstrable roentgen sign in such cases is overlapping of the articular processes (Fig. 1*a*). This can only be visualized on the lateral projections. But if the articular planes of the facets face anteriorly and posteriorly, the lateral projection should, if no other overlapping structures obscure, reveal true widening of these joint spaces (Fig. 4, 5 and 6). As a matter of fact, before a diagnosis of retrodisplacement of a vertebra with such facets can be made, widening of the apophyseal joint space must be demonstrated. Only in one instance will the oblique projections serve to depict widening of the apophyseal joint space in cases of posterior slipping. Such is the case when the planes of the articular facets lie obliquely (Fig. 7*c*). In the lumbosacral region, if the last lumbar segment is deeply set and/or if the iliac alae are large, overlying structures cause obscuration and such widening of the joints is difficult to demonstrate. In such cases, although we have had insufficient experience with this method, we advocate the use of sectional roentgenography or planigraphy. Theoretically at least, this method offers additional help in the differentiation between true and

apparent cases of backward displacement. It is hoped that a report on the value of sectional roentgenography in such problems will be forthcoming.

One cannot overemphasize the essential requirements and value of good quality lateral projections of the lumbosacral spine. Several important anatomical and technical considerations are in order. The sagging phenomenon or lateral flexion of the lumbar spine during recumbency is usually not fully appreciated. Slauson<sup>22</sup> has recently presented a method for clear visualization of the intervertebral spaces and articular margins of the vertebrae. He urges the correct use of the divergent roentgen rays by tilting the roentgen tube in accordance with the radii between the target and the mid-sagittal plane of the patient's spine at different levels, thereby utilizing sagging of the spine to good advantage. Gianturco<sup>8</sup> had previously described a somewhat similar procedure. Since some degree of rotation usually occurs with lateral flexion of the spine, the posterior borders of the vertebrae, especially of the fifth lumbar vertebra, would not be sharply defined and would result in double posterior borders. Thus in many cases retrodisplacement is simulated. There can be little doubt that many cases in the literature actually represent apparent retrodisplacement due to "staircase" effect. For these reasons, we prefer a true lateral spot roentgenogram of the lumbosacral junction or any other vertebral junction with the central ray perpendicular to the mid-sagittal plane of the patient at the desired level. The lateral sagging of the spine should be corrected by adjusting the mid-sagittal plane so that it is parallel to the table top. Of course, there is usually no such problem when the patient is examined in the upright position, unless scoliosis is present. Examination in the erect posture can no longer be considered optional. A comprehensive study of the lumbosacral spine must include projections with the patient standing, preferably according to the program outlined by Knutsson. He advocates upright lateral projections taken with the patient in flexion and extension.

He is thus able to discover cases of "incipient disc degeneration" by demonstrating parallel movement of vertebrae in such cases where no other anatomical evidence of disc degeneration is present.

The longest practical target-to-film distance is, of course, preferable in lateral examinations of the lumbosacral spine in order to decrease the distortion factor. In our studies the mid-sagittal plane of the vertebrae was located 15 cm. above the film and the target-to-film distance 38 inches. The amount of distortion was approximately 15-20 per cent.

Since it is often difficult to obtain clearly defined lateral views of the lumbosacral region which are highly desirable in ascertaining whether or not sublaxation is present, the suggestions of Wilsey, Holly and Cornwell<sup>29</sup> are helpful. They advocate the use of lead shields which conform to the contour of the patient's back and are placed adjacent to the patient on the roentgen table. These lead shields serve to absorb direct radiation. It is usually not appreciated that the Potter-Bucky diaphragm is a source of scattered radiation in lateral examinations of the lumbosacral spine. Contrary to popular conception, it has also been shown that high kilovoltage is preferable in most phases of roentgenography. High kilovoltage will, of course, yield less contrast, but there is a greater scale of densities resulting in roentgenograms of better quality and of greater diagnostic value. Detail can be enhanced further by employing up to 6-8 mm. aluminum filter or its equivalent.

Willis<sup>28</sup> is of the opinion that anatomical variations at the lumbosacral junction are frequently responsible for the roentgen appearance of backward displacement. With this opinion we concur. Willis in his studies of anatomical specimens found that two-thirds of the museum specimens which he examined showed the anteroposterior diameter of the superior surface of the sacrum to be smaller than the inferior surface of the fifth lumbar vertebra, and he attributes the cause of apparent posterior displacement to this difference. He assumes, how-

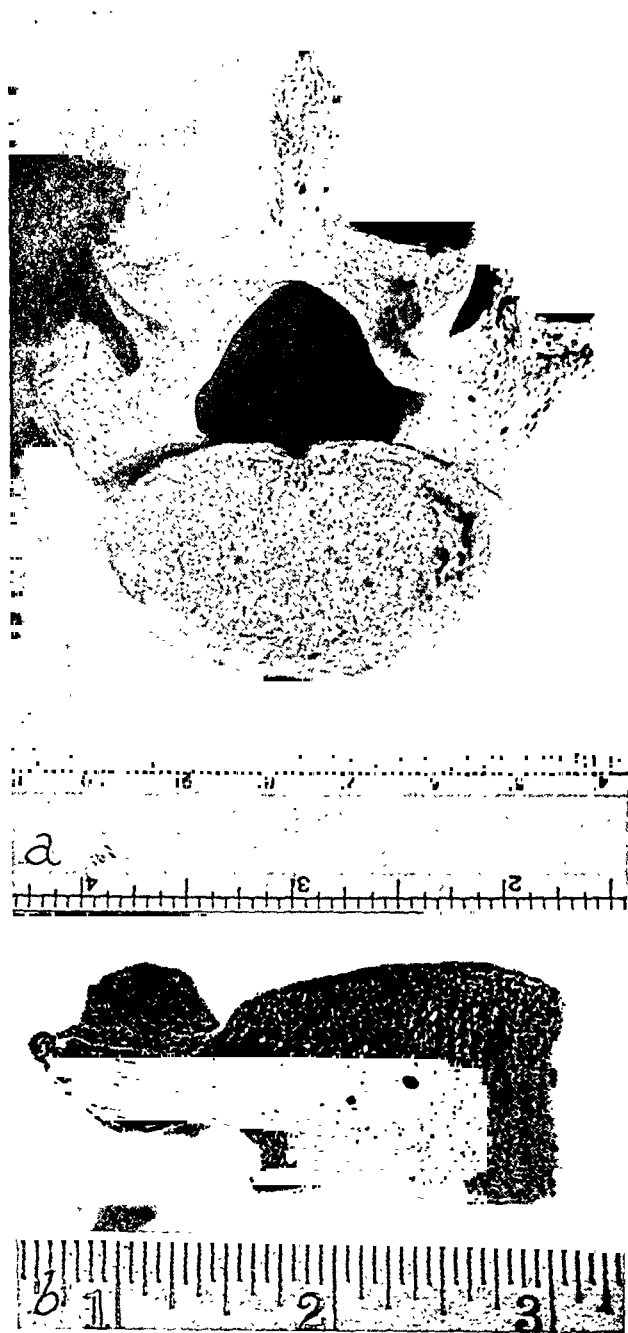


FIG. 8. *a*. Inferior view of fifth lumbar vertebral specimen used in experiments with sacra shown in Figures 9, *a* and *b*, 10, *a* and *b*.

*b*. Lateral view of same specimen showing slight flaring or "skirting" of inferior surface.

ever, that these measured anatomical diameters in all cases are projected on to the roentgenograms, especially in those sacra with concave posterior borders. The question that immediately arises is why do not all of the cases showing such a difference appear as cases of retrodisplacement? We examined roentgenograms of 100 supposedly normal spines and found that the

largest majority, or about 80 per cent, showed this variation and discrepancy without evidence of apparent backward slipping. We believe, therefore, that this difference is not responsible for the appearance of backward subluxation in all cases. Unless there is rotation and sagging with this discrepancy, one cannot simulate displacement because the difference in diameter is evenly distributed anteriorly and posteriorly and the central axes of the vertebrae overlap. So little difference actually exists at the articular borders that it is not perceptible on the roentgenograms. In these cases the eye does not readily detect the small difference in diameters because one follows the general curve of the spine. We have not found that the concave border of the first sacral segment is visualized on true lateral projections because the largest anteroposterior diameter instead of the mid-sagittal diameter is projected on films. Concave surfaces per se are not the cause of false backward displacement. In order to check these impressions we examined two sacra, one with a straight posterior border of the first sacral segment (Fig. 9, *a* and *b*) and the other with a concave posterior border (same specimen as used by Willis in his experiments) as shown in Figure 10, *a* and *b*. The same fifth lumbar vertebra (Fig. 8, *a* and *b*) was used throughout our experimental work with either sacrum. The intervertebral disc was simulated by a fashioned felt pad of disc proportions. Roentgenograms of the lumbosacral specimens thus described were made at 38 inches target-to-film distance with the mid-sagittal plane of the specimens 15 cm. above the cassette. Exposures were made with the central ray at the fourth and fifth lumbar intervertebral levels. The distortion was approximately 13 per cent.

A true lateral projection (Fig. 11*a*) of the sacrum with the concave posterior first sacral segment (hereafter referred to as "concave" sacrum) reveals only one posterior border; the concavity is not visualized. With small lead markers in the mid-sagittal plane on the posterior aspects of the fifth

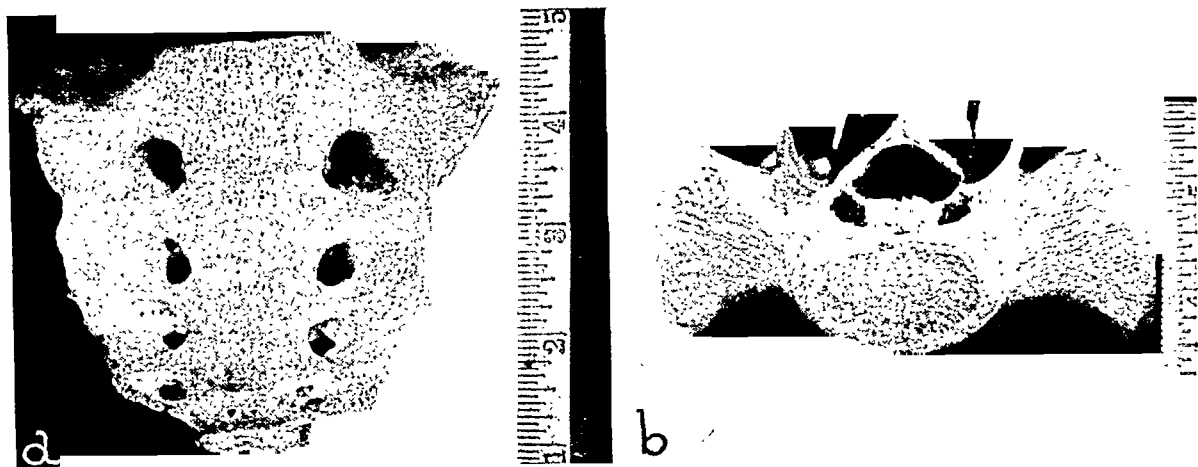


FIG. 9. *a* and *b*. Frontal and top views of sacrum, the first segment of which possesses a straight posterior border.

lumbar and the first sacral segments (Fig. 11*b*) the concavity of the sacrum is anterior to the actual posterior border of the sacrum on the roentgenogram. In Figure 11, *a* and *b* the central ray is at the level of the lumbosacral disc.

The effect of slight rotation of the "concave" sacral specimen is well demonstrated in Figure 11*c*, a double posterior sacral border being created by the concavity anteriorly. The illusion of posterior displacement is, in great measure, due to "flaring" or "skirting" of the fifth lumbar vertebra which is normally present laterally. With slight rotation the "skirting" is thrown into relief and the inferior articular margin appears to project backward beyond the cor-

responding posterior sacral border.

Shift of the central ray to the level of the fourth lumbar intervertebral space causes apparent narrowing of this disc and creates ovoid images of the adjacent articular surfaces of the sacrum and fifth lumbar vertebra (Fig. 11*d*). The effect of slight rotation in the production of apparent backward displacement is illustrated in Figure 11, *e* and *f*.

The experiments cited above were repeated with the "straight" sacral segment (Fig. 9, *a* and *b*). With the central ray at the level of the lumbosacral junction one posterior border is again visualized (Fig. 12*a*). There was, however, one difference between the appearance of the "concave"

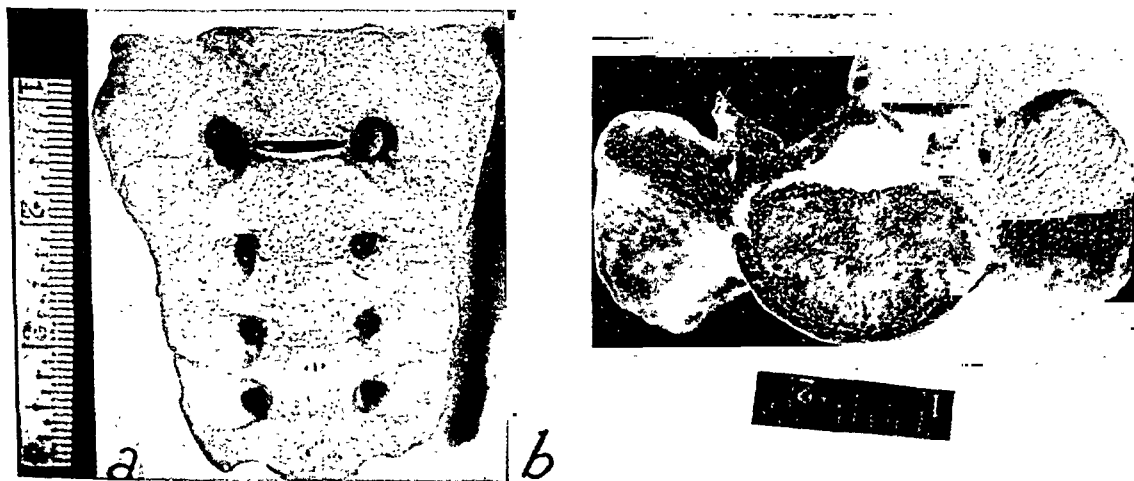


FIG. 10. *a* and *b*. Anterior and superior views of the other sacrum. Posterior border of first sacral segment is concave. (Courtesy of Dr. Hoerr of Hammond Museum. Same specimen used by Dr. Willis.)

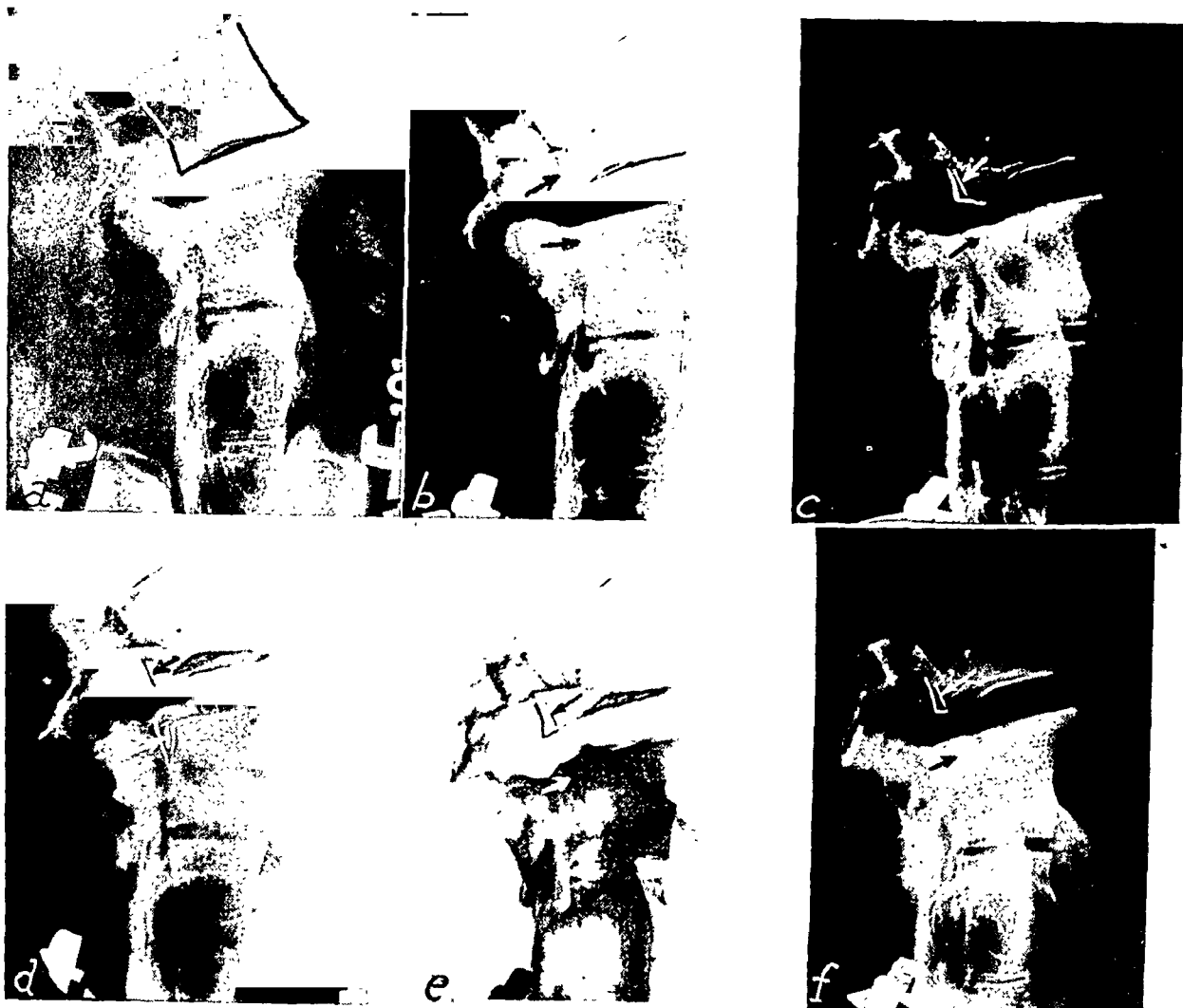


FIG. 11. *a*. Perfect lateral projection of lumbosacral specimen formed by fifth lumbar vertebra shown in Figure 8, *a* and *b* and "concave" sacrum shown in Figures 10, *a* and *b*. Concavity of posterior surface of first sacral segment is not visualized. The intervertebral disc was fashioned of orthopedic felt material. The central ray is at level of lumbosacral junction. (Specimen measurements: mid-sagittal diameters of top of sacrum and inferior surface of fifth lumbar vertebra are 28 and 29 mm., respectively. The comparable film measurements are 35 and 36 mm., indicating approximately 20 per cent distortion. (Retouched.)

*b*. Lateral view of same specimen as in *a* with lead markers (arrows) placed on posterior aspects of fifth lumbar vertebra and sacrum (concave posterior border) in mid-sagittal plane. Central ray is at level of lumbosacral joint. One posterior upper sacral border is visualized and no parallel displacement is disclosed.

*c*. Lateral projection of specimen with central ray still at level of lumbosacral junction but specimen is rotated 10 degrees resulting in apparent backward displacement. Lead marker (arrow) on sacrum delineates concavity and double posterior sacral border. The flaring of the posteroinferior aspect of the fifth lumbar thrown into relief by the slight rotation is responsible for appearance of apparent retrodisplacement. Lead marker (arrow) shows true posterior limits of fifth lumbar vertebra. (Retouched.)

*d*. True lateral view of specimen with central ray shifted to level of the fourth lumbar vertebra, resulting in apparent narrowing of the intervertebral space. (Retouched.)

*e*. Apparent backward displacement produced by 10 degrees rotation of specimen, central ray at level of fourth lumbar vertebra. True location of posterior margins of fifth lumbar and first sacral segments is indicated by the lead markers. (Retouched.)

*f*. Same specimen with rotation and sagging (slight lateral flexion) of lumbosacral junction, central ray at level of fourth lumbar vertebra, again producing apparent backward displacement. The divergent roentgen rays are parallel to articular margins; therefore, the intervertebral space does not appear narrowed. (Retouched.)



FIG. 12. *a*. True lateral projection of lumbosacral specimen, the posterior upper sacral border of which is straight (Fig. 9, *a* and *b*). The central ray is directed at and through the lumbosacral junction. Lead markers (arrows) on posterior borders in mid-sagittal plane. Roentgen appearance identical with that in Figure 11*b* where the posterior sacral border is concave, thus indicating that the contour of the posterior surface of the sacrum does not influence apparent parallel displacement in true lateral projections.

*b*. Lateral projection of same specimen shown in *a* with approximately 10 degrees rotation shows single posterior sacral outline but flaring of fifth lumbar vertebra causes apparent posterior displacement. (Retouched.)

*c*. Lateral projection with sagging and rotation again shows increased apparent posterior displacement described in *b*. In addition, there is apparent narrowing of lumbosacral space. (Retouched.)

*d*. Technique same as in *a* but central ray is shifted to level of fourth lumbar vertebra. Note apparent narrowing of posterior portion of disc but no posterior displacement. (Retouched.) Lead markers are delineated by arrows.

*e*. Conditions identical with those in *c*, but central ray is at the level of the fourth lumbar vertebra. Note apparent displacement of fifth lumbar vertebra but the lumbosacral disc now appears to be of normal width, divergent roentgen rays being responsible for clear visualization of the interspace.

and "straight" sacral segments. As the reader will recall, slight rotation of the "concave" sacrum produced a double posterior sacral border while rotation of the straight sacrum resulted in only a single posterior sacral border (Fig. 12*b*). On the true lateral projection the posterior margin of the first sacral segment is represented by

a single line, and posterior displacement is simulated by the flaring of the inferior articular portion of the fifth lumbar vertebra. The addition of sagging to the effect of rotation, as one would expect, serves to exaggerate the illusion of posterior displacement and once again the intervertebral space appears narrowed (Fig. 12*c*).



Shifting the roentgen tube or central ray from the level of the fifth lumbar to the fourth lumbar intervertebral space fails to create the illusion of backward displacement (Fig. 12*d*), but the intervertebral space is narrowed. Rotation and sagging again serve to produce apparent subluxation (Fig. 12*e*) but the intervertebral space, due to utilization of the divergent roentgen-ray beam, is not narrowed.

Our studies were continued by wedging

hind the corresponding sacral margin. The intervertebral space also appears to be narrowed. These findings are increased when the entire specimen is rotated 5 to 10 degrees (Fig. 13*b*). Later the entire specimen with wedged lumbosacral disc was tilted so that the mid-sagittal plane of the sacrum produced an angle of 10 to 15 degrees with the plane of the table top. Here too posterior subluxation is simulated (Fig. 13*c*) but the articular margins of the



FIG. 13. *a*. Lateral projection after lateral wedging of felt disc, simulating sagging (lateral flexion), and with slight rotation of the specimen (sacrum with straight posterior border) shows apparent posterior displacement due to the posterior and lateral flaring of the fifth lumbar vertebra. The central ray is at level of lumbosacral joint. Note apparent narrowing of the disc. (Retouched.)

*b*. Specimen same as in *a* but central ray is shifted to level of fourth lumbar vertebra. The projection again reveals apparent backward displacement. (Retouched.)

*c*. Same conditions as in *b* plus rotation of specimen exaggerates apparent retrodisplacement. Wedging of disc as described in *a* and *b* present.

one-half of the lumbosacral disc, in order to imitate conditions in vivo. Additional felt was introduced on one side of the intervertebral space in order to duplicate living conditions when a patient is examined in lateral recumbency. The first studies with this specimen were made with the mid-sagittal plane of the sacrum parallel to the film, while the corresponding plane of the fifth lumbar vertebra was tilted. With the central ray focused at the lumbosacral joint, posterior slipping is simulated by visualization of the fifth lumbar flaring posterolaterally (Fig. 13*a*). Thus, the most posterior margin of the inferior aspect of the fifth lumbar vertebra is projected be-

hind the corresponding sacral margin. The intervertebral space also appears to be narrowed. These findings are increased when the entire specimen is rotated 5 to 10 degrees (Fig. 13*b*). Later the entire specimen with wedged lumbosacral disc was tilted so that the mid-sagittal plane of the sacrum produced an angle of 10 to 15 degrees with the plane of the table top. Here too posterior subluxation is simulated (Fig. 13*c*) but the articular margins of the

Similar studies were carried out with human subjects, cases selected from a group of nurses whose hip measurements were a good deal greater than their waist diameters. These subjects had no back complaints. Miss D. S., aged nineteen, a student nurse, measured 34 cm. between the femoral trochanters and had a waist diameter of 26 cm. To further exaggerate this difference, the hips were elevated off the table for a distance of several centimeters. The lateral projection (Fig. 14*a*) shows ap-

parent retrodisplacement of the fifth lumbar vertebra and narrowing of the fifth lumbar intervertebral space. At re-examination with the central ray at the level of the lumbosacral junction, and with the

The effect of flaring of the posteroinferior margin of the fifth lumbar vertebra is well demonstrated in the patient, Mrs. S. S., aged twenty-six, whose lateral roentgenogram shows apparent retrodisplacement

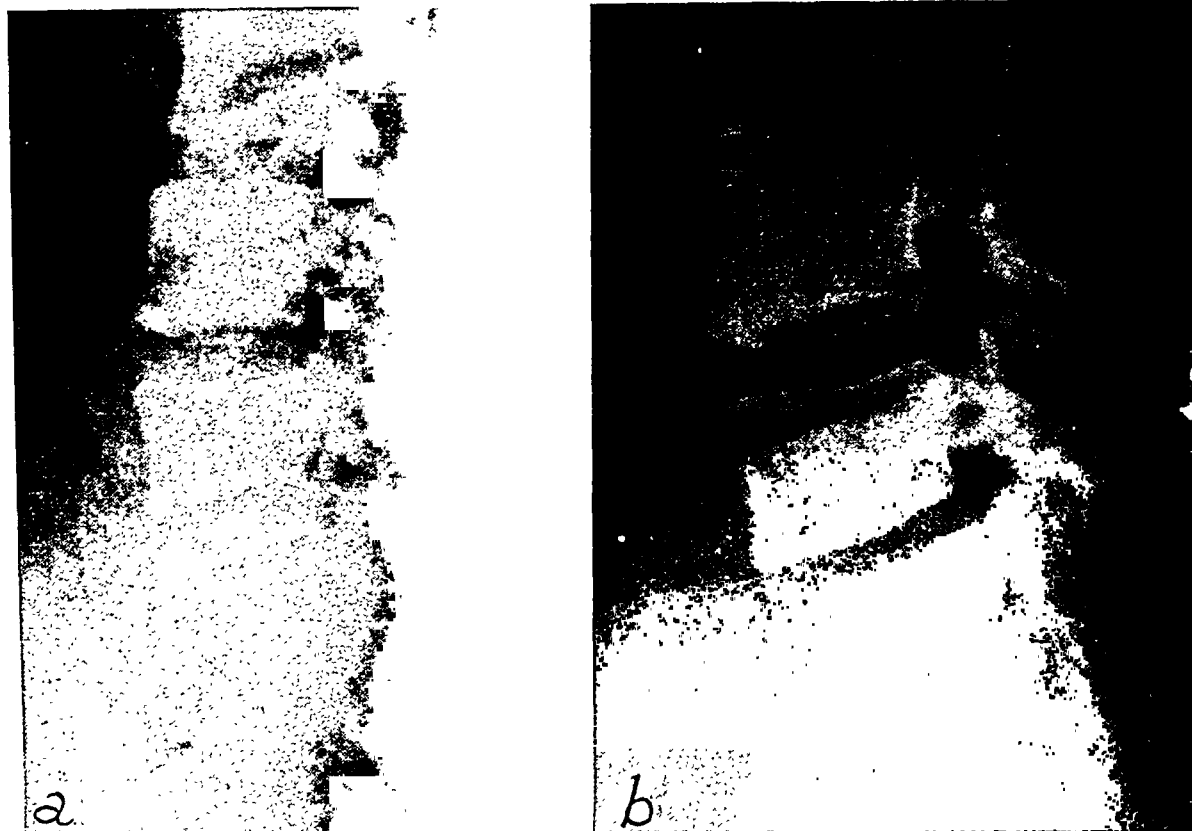


FIG. 14. *a*. Miss D. S., aged nineteen, student nurse. The transverse diameter of the pelvis measured 34 cm. while the transverse diameter at the waistline measured 26 cm. Lateral roentgenogram taken with hips elevated off table top for approximately 9 cm. in order to produce slight sagging in lower lumbar region. Note apparent narrowing of the lumbosacral joint and apparent posterior displacement of fifth lumbar vertebra. Results comparable to experimental findings shown in previous illustrations.

*b*. Lateral roentgenogram of same patient, the hips no longer elevated and sagging eliminated, with central ray aimed at the lumbosacral junction. Neither retrodisplacement nor apparent narrowing of disc is observed.

spine straightened on the table, the apparent backward slipping at the lumbosacral level disappeared (Fig. 14*b*).

Another illustration of this principle is shown by a patient, aged thirty-five, who, in the routine lateral recumbent roentgenogram of the lumbosacral spine, exhibited apparent posterior slipping and narrowing of the intervertebral space (Fig. 15*a*). The upright spot roentgenogram of the lumbosacral joint, which eliminated the factor of lateral flexion, shows no abnormality (Fig. 15*b*).

(Fig. 16) but the apophyseal joints are normal in width. In this case one cannot make a diagnosis of true retrodisplacement.

There are cases in which no anatomical factors, such as flaring of the fifth lumbar vertebra posteriorly, bevelled posterosuperior sacral margin, etc., are present, and yet retrodisplacement is simulated. Such a case is represented in Figure 17, Mr. M. R., aged forty, whose articular facets in the lumbosacral region face anteriorly and posteriorly. The apophyseal joints are well visualized and show no appreciable widen-

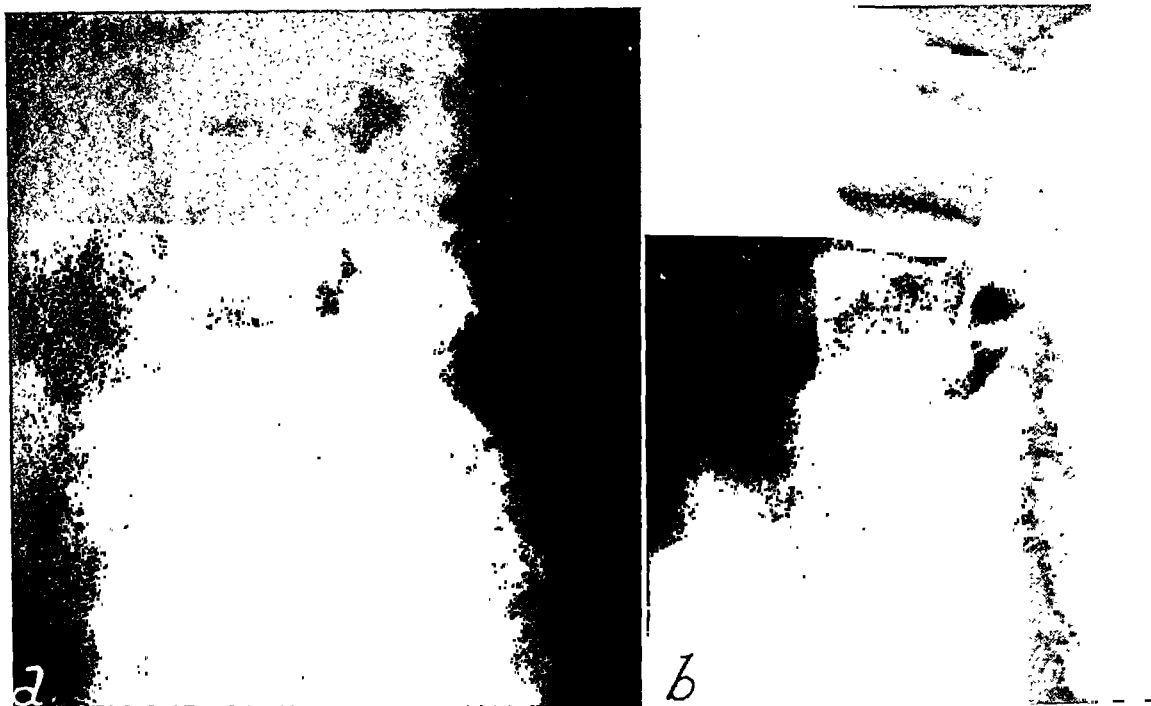


FIG. 15. *a*. Mrs. J. D., aged thirty-five. Lateral view in recumbency showing apparent posterior narrowing of lumbosacral interspace and pseudo-backward displacement of fifth lumbar vertebra.

*b*. Same patient examined in vertical position, lateral sagging being eliminated, shows normal lumbosacral region.

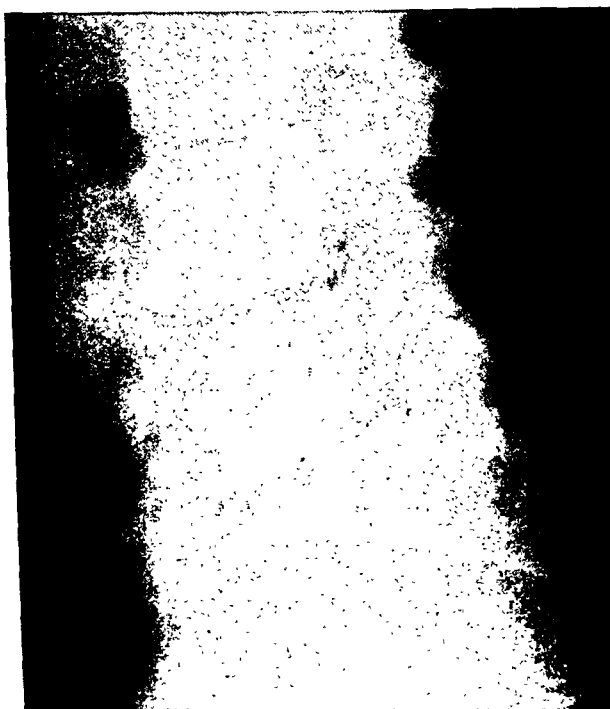


FIG. 16. Mrs. S. S., aged twenty-six. Apparent backward displacement due to unusually marked flaring of posteroinferior margin of fifth lumbar vertebra.



FIG. 17. Mr. M. R., aged forty. Apparent backward displacement with normal apophyseal joint width. The facets face anteriorly and posteriorly. Roentgen measurements of superior surface of sacrum and inferior surface of fifth lumbar vertebra are 40 and 44 mm., respectively. Note, however, that anterior margins do not overlap and interspace is of normal width. In this case the discrepancy of the anteroposterior diameters is cause of apparent retrodisplacement.

ing. One must therefore consider such a case as apparent and due to an optical illusion as described by Willis. The measurements of the adjacent surfaces of the fifth lumbar and first sacral segments are 44 and 40 mm., respectively. Rarely does one observe a bevelled posterosuperior border of the sacrum (Fig. 19) which obviously, by virtue of the fact that the articular surface is shortened in the anteroposterior axis, serves to create the illusion of posterior displacement, but the general curve of the lumbosacral spine is smooth and the apophyseal joint spaces are normal in width.

An excellent example of carelessness on the part of a technician is demonstrated by the next pair of roentgenograms of the same patient. When asked to "spot" over the lumbosacral junction, the technician reduced the target-to-film distance and obtained a markedly distorted image. The

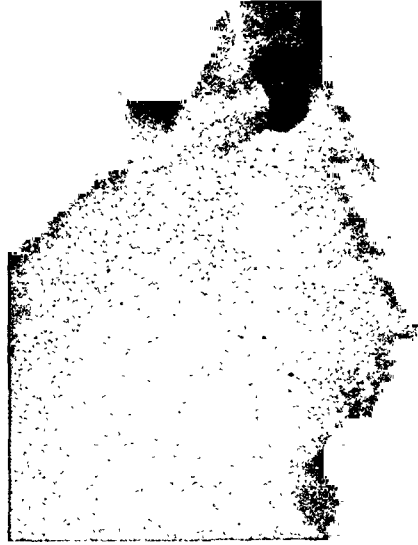


FIG. 19. Mrs. B. R., aged twenty-six. Lateral projection showing bevelled posterosuperior margin of first sacral segment which is responsible for 4 cm. difference in the anteroposterior diameters of the opposing surfaces at the lumbosacral junction. No true backward displacement is present.



FIG. 18. Mr. G. G., aged fifty-two. Lateral view showing apparent slight displacement of fourth lumbar vertebra on fifth lumbar vertebra because of tapering of fifth lumbar vertebral body, the latter assuming sacral proportions or characteristics. Narrowing of the lumbosacral joint is due to sacralization of the fifth lumbar vertebra.

effect of this short target-to-film distance is illustrated in Figure 20a, where marked distortion of the diameters of the vertebrae is obtained and posterior subluxation is simulated. The other upright lateral projection (Fig. 20b) shows smaller vertebral images and less, if any, apparent slipping. The apophyseal joints are not widened.

Flaring of the inferior border of the fifth lumbar vertebra has received little attention as a possible factor in the causation of confusing shadows on roentgenograms. Normal anatomical flaring is present, for the most part, on the lateral aspects. If the spine is rotated, this flaring is thrown into relief and becomes more apparent. This flaring, when contrasted against the adjacent posterior border of the sacrum, simulates retrodisplacement, and lends additional width to the mid-sagittal diameter of the inferior surface of the fifth lumbar vertebra. Along similar lines arthritic lip-ping can produce the same effect. It has

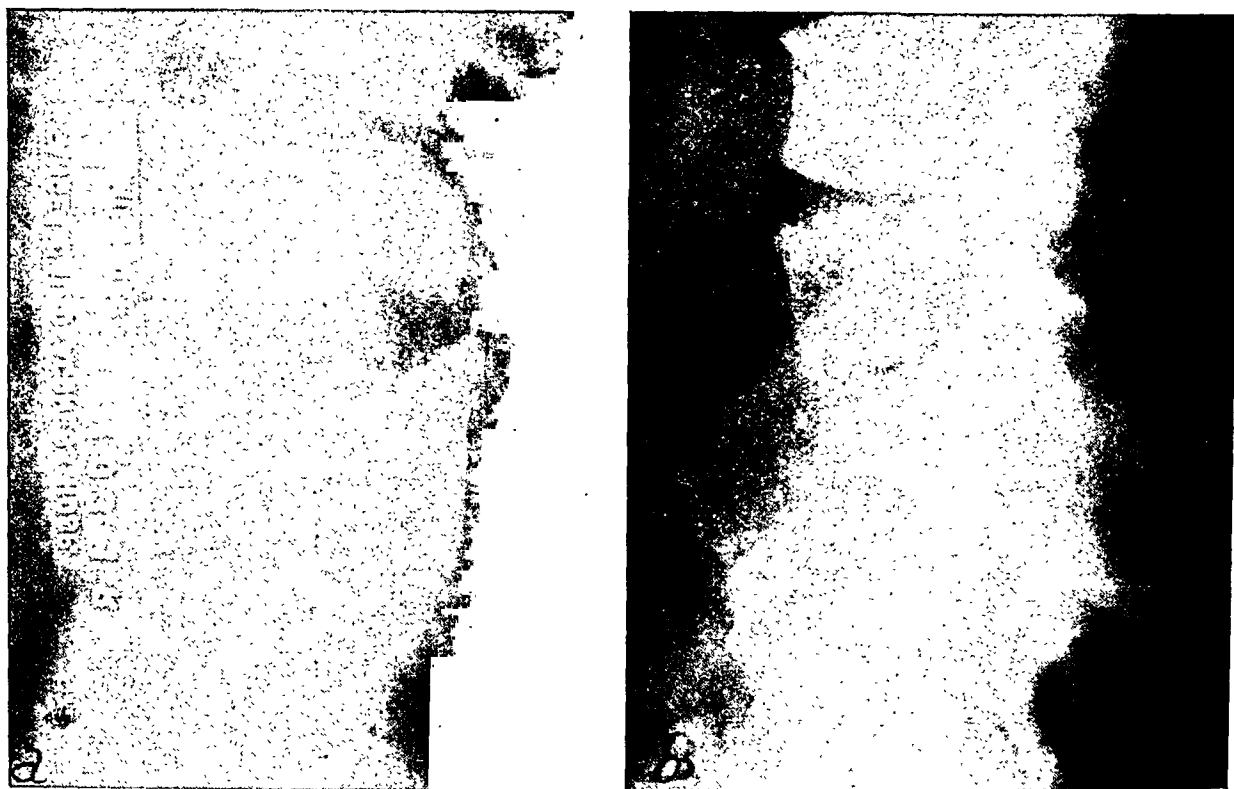


FIG. 20. *a.* Mr. A. S., aged fifty-three. Upright lateral view showing apparent backward displacement and narrowed space in lumbosacral region due to short target-to-film distance and slight rotation.  
*b.* Same case. Less distortion and less rotation effect because of greater target-to-film distance.

been our experience that overlapping bone shadows in many instances confuse and obscure the normal anatomical landmarks on the roentgenograms. We found that the posterior border of the sacrum is simulated by various overlapping bone structures on the lateral projection. These disturbing shadows must be analyzed and resolved before an accurate interpretation can be advanced. The lumbosacral junction is often difficult of visualization in the lateral view due to a deeply set last lumbar vertebra. In such event, the overlapping iliac crests and wings obscure the lumbosacral junction. It occurs to us that in such cases planigraphy in the lateral position would be of great value.

One cannot, therefore, by any stretch of the imagination, exaggerate the potentialities of anatomical and technical variations, so far as they affect roentgen visualization of the lumbar vertebrae and simulate pathological conditions.

#### CRITERIA FOR THE ROENTGEN DIAGNOSIS OF RETRODISPLACEMENT OF LUMBAR VERTEBRAE

We have attempted to enumerate a set of criteria for a diagnosis of posterior displacement of lumbar vertebrae. These criteria were formulated following a critical analysis of the medical literature and rather extensive study of a large series of roentgenograms of backward displacement of lumbar vertebrae. It should be apparent and appreciated that one will not expect or discover all of the signs to be present at any one lumbar level, the roentgen features varying considerably from the first lumbar to the lumbosacral level.

1. *Degeneration with or without actual narrowing of the interspace is essential.* Roentgen signs of disc degeneration are as follows: (*a*) narrowing of the intervertebral space; (*b*) reactive changes at articular margins of the vertebral segments; (*c*) vacuum phenomenon; (*d*) calcification of

the intervertebral disc; (e) instability—abnormal relation of vertebrae, such as retrodisplacement, pseudospondylolisthesis, etc.; (f) abnormal motion of vertebrae; (g) alteration of the lumbar curve.

2. *The posterior border, as well as the anterior border, of the cephalad vertebral body must be displaced posterior to the corresponding portion of the caudad vertebra.* The continuity of the lumbar curve is broken.

3. *Narrowing of the intervertebral foramina—at least in the anteroposterior direction.* If the intervertebral space is decreased, vertical narrowing of the intervertebral foramina will occur. The anteroposterior narrowing of these foramina results in an "hour-glass" appearance. This encroachment is due to approximation of the posteroinferior margin of the cephalad vertebral body and the superior articular process of the adjacent caudad vertebra.

4. *Displacement of the facets and/or widening of the apophyseal joint space must be present.* If the facets are of the internal-external type, widening of the overlapping articular processes in the sagittal plane will be disclosed. If the facets face anteriorly and posteriorly, widening of the joint space must be demonstrated.

5. *Prominence or protrusion of the spinous process of the displaced vertebra on the sagittal projection.*

6. *Alteration of the lumbar curve.*

7. *Roentgen signs of retrodisplacement not eliminated by technical means.*

#### SUMMARY AND CONCLUSIONS

A review of the literature on the subject of retrodisplacement of vertebrae is presented. An attempt has been made to crystallize the various concepts at present existent with reference to this condition. We have found that backward displacement of lumbar vertebrae, the fifth lumbar vertebra included, is a pathological entity which is encountered with sufficient frequency to deserve greater recognition.

On the basis of our anatomical and roentgenological studies an etiological classification of backward slipping of lumbar

vertebrae is offered. The etiological factors responsible for true backward displacement are degenerative processes, disease, trauma and/or congenital anomalies. Criteria for distinguishing and segregating such cases of true backward displacement from those due to anatomical and technical factors—apparent retrodisplacement—are listed.

In the light of recent advances in roentgen technique and interpretation a more comprehensive roentgen examination of the lumbar spine is recommended if cases of backward displacement are not to be overlooked.

We wish to express our thanks to Dr. N. Hoerr, Western Reserve Medical School, for the opportunity of examining sacrum No. 1097 of the Hammond Museum.

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# OSTEOCHONDRITIS OF THE INTERNAL CUNEIFORM, BILATERAL

## CASE REPORT

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THE osteochondritides have been widely presented and covered in the literature, demonstrating that the condition occurs mainly in the spine and extremities. The etiology is not definitely known but it is thought to be due to a disturbance of the

ally in one case, and the second case presented the same findings in the right foot.

Both of the above patients were males, each six and one-half years old. The first case gave a history of slight trauma brought about by twisting the foot following a mis-

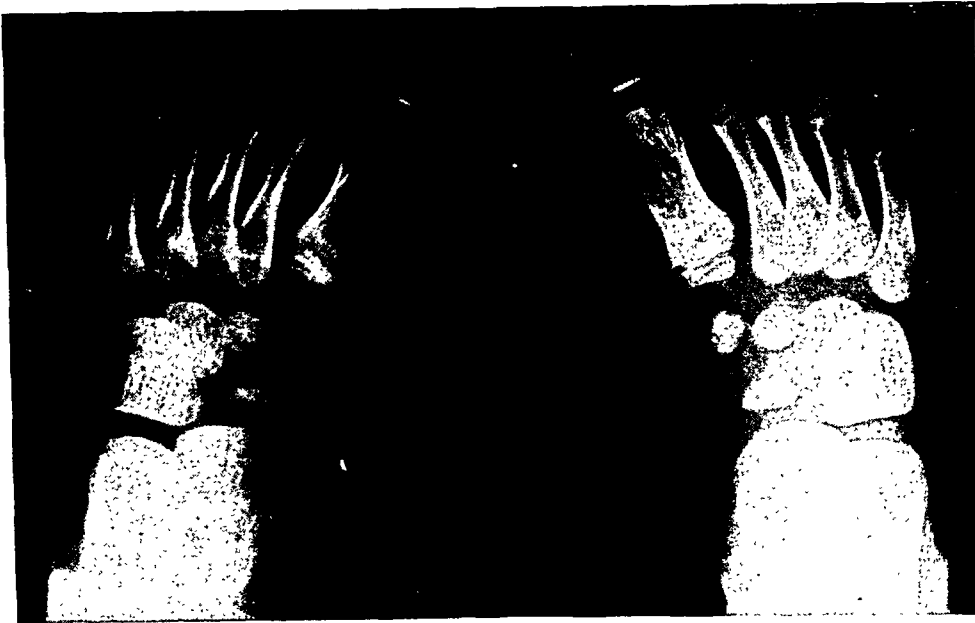


FIG. 1. Dorsoventral view showing irregularity and fragmentation of the internal cuneiforms bilaterally with condensation and rarefaction. Flattening of the scaphoids with irregularity of outline and condensation and rarefaction is also noted bilaterally.

nutritional status locally, or upon an endocrine basis, or possibly trauma of a sort, producing a disturbance in the chondral ossification with aseptic necrosis in the epiphysis. Suffice it to say that osteochondritis is rarer in certain areas and with this in mind this case report is presented because of the paucity of like cases in the literature.

Until 1933 a study of the literature revealed no reports on osteochondritis of the internal cuneiform. Then Buchman<sup>1</sup> presented a study of 2 cases of osteochondritis of the internal cuneiform associated with like changes in the tarsal scaphoid bilaterally.

The second case gave no history of trauma. By chance only his right foot was roentgenographed for comparison with the first case.

Haboush<sup>2</sup> about the same time presented one case of a white male, aged four and one-half years, with bilateral involvement of the internal cuneiform and also the tarsal scaphoids. No definite history of trauma was elicited in this case. The complaint was pain in the instep with limping on the left side.

A further check of the literature to date reveals no other reports, so with this in mind a fourth case is offered.



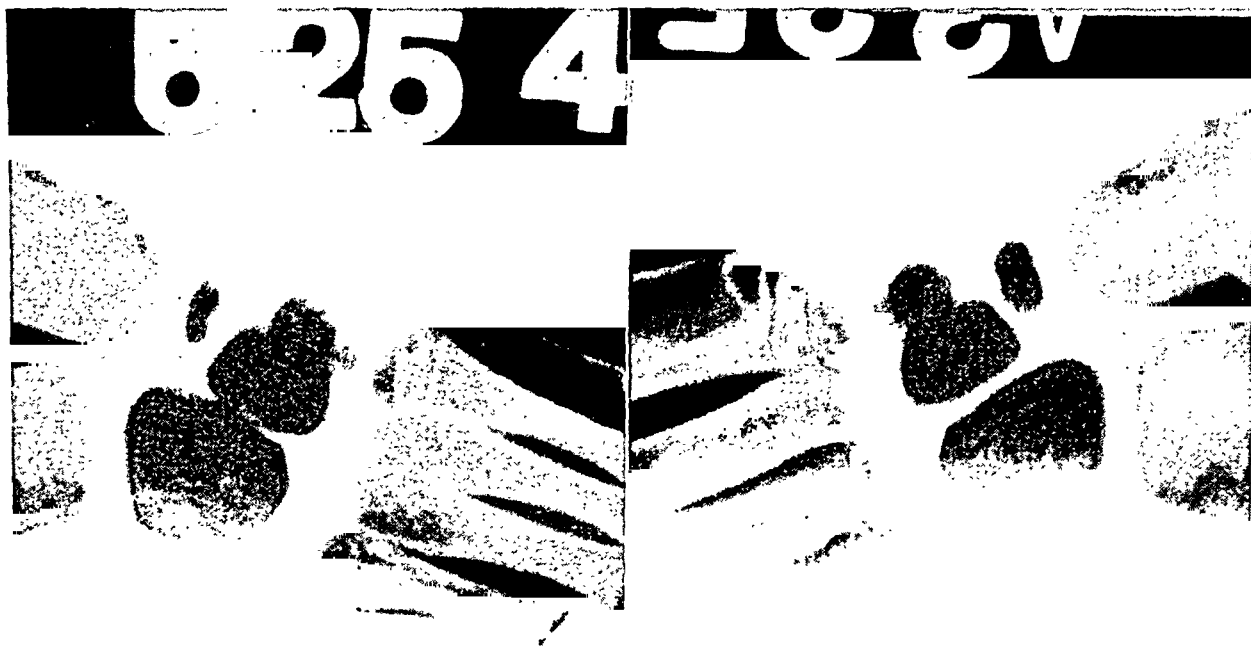


FIG. 2 and 3. Oblique views again show the marked irregularity of outline of the cuneiforms, the condensation and rarefaction. The flattening, irregularity, condensation and rarefaction are also noted in the scaphoids.

#### REPORT OF CASE

A mother presented her four year old child, a white male, who complained of pain over the dorsum of the left foot which was more noticeable after running. Patient also had a tendency to walk on the outside of the feet and would wear down the outer half of the heels. This factor had been especially noted for the previous three months.

History elicited no trauma and physical examination revealed no tenderness or deformity of the feet. No complaints were noted in the right foot which was roentgenographed for comparison. Patient was to return at intervals for further check for roentgen changes but failed to do so.

Roentgenographic examination (Fig. 1) of both feet showed an irregularity of the outline of the internal cuneiforms both of which appear smaller in size than the adjacent tarsal bones with the exception of the scaphoids. The center of each cuneiform shows slight condensation and the inner half some rarefaction. The oblique views (Fig. 2 and 3) show a greater irregularity of outline of the right cuneiform than the left, the latter being the side of complaint. The scaphoids of both feet are smaller than normal, flattened and irregular, both showing some condensation and rarefaction. No significant changes are noted in the remaining bones of the feet.

A comparison of this case with the previous 3 cases presented by Buchman and by Haboush shows a marked similarity in the findings. In this case no history of trauma was found. The same findings were noted in 2 of the other 3 reported cases. All of the patients have been males ranging in age from four to six and one-half years of age, and the presence of bilateral involvement in 3 of the cases with complaints only on one side seems to rule out trauma as a definite etiological factor in this small group.

#### SUMMARY

A single case of osteochondritis of the internal cuneiform of both feet in association with osteochondritis of the tarsal scaphoids in a white male of four years of age is presented making a total of four cases reported in the literature.

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# THE TREATMENT OF RECURRENCES AND EVALUATION OF CRITERIA FOR THE SELECTION OF TREATMENT OF CANCER OF THE LARYNX\*

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THE initial treatment of cancer of the larynx by laryngofissure, laryngectomy and irradiation has been widely discussed in the American and foreign literature. There is no one method by which all cases of cancer of the larynx can be treated and the results better than the combined results of these three methods. Some laryngologists, surgeons and radiologists consider these methods competitive. This concept is erroneous. The only consideration should be the patient and what treatment modality will give him the greatest chance of obtaining a complete arrest or cure of his disease. All factors should be weighed carefully, and the established criteria should determine the best method of treatment.

All three methods have their failures. The patients who are not cured by these procedures and who develop recurrences or metastases present problems of important decision and management. Not infrequently these patients are considered hopeless and are given palliative treatment only. Many of this group, if properly and adequately treated, could be cured.

The purpose of this paper is to review the experiences which we have had at Temple University Hospital in the treatment of recurrences and metastases of cancer of the larynx, and to evaluate the criteria upon which the selection of treatment is based.

## RECURRENCES AFTER LARYNGOFISSURE

The "laryngofissure" operation means the procedure by which the thyroid cartilage is divided and the cancer involved tissue is resected subperichondrially. The reported cures for this procedure are 80 to 85 per cent.<sup>8</sup>

Following laryngofissure, recurrences are observed in about 17 per cent of the cases. In another 3 to 5 per cent metastases are the cause of death. In an attempt to explain a possible cause for recurrence, Broyles<sup>3</sup> calls attention to the anatomy. The tendon at the anterior commissure is firmly attached to the cartilage. Laterally, the perichondrium of the thyroid cartilage may be easily separated but at the anterior commissure, where the tendon joins the cartilage, there is no line of cleavage. It is here that residual disease may give rise to an early recurrence. To prevent this, Broyles advises the removal of the diseased vocal cord, the anterior ridge or crista of the thyroid cartilage, and the anterior portion of the healthy cord.

In a series of 188 cases of cancer of the larynx treated by all methods (laryngofissure, laryngectomy and irradiation) from 1930 to 1937 inclusive, studied and analyzed by Jackson, Blady and Norris recently, there were 12 failures in a group of 59 patients treated by laryngofissure and followed for a period of five years and longer.<sup>11,12</sup> Ten of these failures developed recurrences and only 4 of these patients received additional treatment; of these 4, 3 are living and free of disease (Table 1). In 6 cases no treatment was administered. It is probable that if the recurrence in these 6 patients had been discovered early, and proper treatment instituted, some of them might have survived.

In a series of cases observed from 1930 to 1941 inclusive, 5 patients were treated by irradiation for a recurrence after laryngofissure. Two patients of this group survived seven and seventeen years respectively, after the initial laryngofissure and subse-

\* Presented at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

TABLE I

ANALYSIS OF FAILURES IN 12 CASES  
OF LARYNGOFISSURE

A. Developed recurrences	10 cases
1. Dead of disease	5
2. Dead of disease; treated by laryngectomy	1
3. Living and well; no evidence of disease, treated by laryngectomy	1
4. Living and well; no evidence of disease, treated by roentgen irradiation	2
5. Lost with disease	1
<i>Five year salvage of recurrences</i>	
<i>3 cases, 30%</i>	
B. Developed metastases and died of disease	2 cases

From 1930 to 1937, 71 laryngofissure operations were performed in the Chevalier Jackson Bronchoscopic Clinic of Temple University Hospital. In this group there were 10 recurrences. The recurrence rate was determined as follows: 7 patients died of other causes without evidence of recurrent or metastatic disease prior to five year survival; an additional 5 were lost to follow-up. Subtracting these cases, leaves a determinate group of 59 cases. Recurrence rate— $10/59=17$  per cent.

quent irradiation (Table II).

Based on the above results and on observations in cases treated since 1941, but who are not being reported in this series, we feel that *recurrence after a laryngofissure operation can be successfully treated either by laryngectomy or by roentgen irradiation*. It is most important that the diagnosis of a recurrence be made early and that it is verified by histopathologic study.

The decision as to whether the recurrence should be treated by laryngectomy or ir-

radiation is not always an easy one. A laryngofissure wound heals by scar tissue. Because of this, oftentimes clinically it is impossible to determine whether there is deep infiltration and involvement of the cartilage or whether the recurrence is superficial. When there is suggestive evidence of invasion of cartilage, or if the lesion is subglottic, laryngectomy is advised. Conversely, if the recurrence has the appearance of being superficial, then radiation is the treatment method of choice. In the consideration of the latter decision we again call attention to Broders' grading of tumors. In our experience, squamous cell carcinoma, Grade 3 is less radiosensitive than Grades 1 2 and 4. We prefer laryngectomy to radiation in the treatment of squamous cell carcinoma, Grade 3 lesions.

TREATMENT OF RECURRENCES AFTER  
IRRADIATION

Eighty-one patients were treated by roentgen irradiation in the period from 1931 to 1941 inclusive, and are the bases of the present study. Fifty-six of these cases were classified intrinsic, and 25 extrinsic. In the intrinsic group there were 13 recurrences, (23 per cent) and in the extrinsic, 6 recurrences (24 per cent).

An analysis of the 19 recurrences reveals that 14 received additional treatment. Five patients survived five or more years after treatment of the recurrence for a survival rate of 26 per cent.

In the intrinsic group, 6 patients had a

TABLE II

## RECURRENCES AFTER LARYNGOFISSURE TREATED BY IRRADIATION

Case No.	Histo-pathologic Grade	No. of Months Recurrence after Laryngofissure	Survival after Roentgen Irradiation for Recurrence	Total Survival Period
1 G.B.	1	2	18 mo.	20 mo.
2 E.H.	2	31	51 mo.	82 mo.
3 S.I.	4	3	24 mo.	27 mo.
4 E.C.	4	8	26 mo.	34 mo.
5 H.N.	2	89	9 yr.	17 yr.
			living and well	living and well

squamous cell carcinoma, Grade 2, and 7 had Grade 3.

Four patients with Grade 2 cancer received a second course of roentgen irradiation and 2 of these survived eight and eleven and one-half years respectively. One is still living, free of disease, and the other survived a total of eleven and one-half years and died of other causes at the age of eighty-six. The remaining 2 died of their disease five and six months after treatment of the recurrence. A fifth patient had a laryngectomy performed for a recurrence and survived an additional thirty months during which time the tumor recurred and metastasized extensively.

Of the 7 cases of squamous cell carcinoma Grade 3, 5 received a second course of roentgen irradiation. One patient was alive and free of recurrent or metastatic disease a total of fifty-eight months when lost. It can be presumed that this patient survived a total of five years. Efforts are still being expended to locate this patient in another country. Another patient with a recurrence received a second course of 6,000 roentgens,

Treatment of Recurrence by	Number of Cases	Five Year Survival
Roentgen irradiation	12	4
Laryngectomy	2	1
None	3	0
Not known	2	0

measured in air, to the anterior neck through a 7 cm. portal directed at the larynx. He developed a second recurrence nine months later, for which a laryngectomy was performed. He is now living and free of disease fifty-two months after the laryngectomy. The other 3 are dead of disease, with an average total survival time of thirty-seven months, and an average survival time after the recurrence of twelve months. Two received no treatment and survived six and twenty-one months respectively, after the diagnosis of recurrence.

Of the group of 6 patients with recur-

TABLE IV  
ANALYSIS OF RECURRENCES IN INTRINSIC GROUP TREATED  
INITIALLY BY ROENTGEN IRRADIATION

Case	Age	Histo-pathologic Grade	Metastases	Recurrence Time after Irradiation	Treatment of Recurrence	Survival after Recurrence	Total Survival Period
1 G.C.	74	2	No	8 yr.	X-ray	42 mo.	138 mo.*
2 J.L.	44	2	Yes	5 mo.	X-ray	6 mo.	13 mo.
3 S.H.		2	—	5½ yr.	Unknown		
4 C.M.	50	2	No	10 mo.	X-ray	84 mo.	94 mo.†
5 F.D.	72	2	No	3 mo.	X-ray	5 mo.	8 mo.
6 G.F.	68	2	Yes	22 mo.	Laryngectomy	30 mo.	52 mo.
7 M.A.	71	3	No	14 mo.	None	21 mo.	32 mo.
8 E.H.	47	3	Yes	51 mo.	X-ray	5 mo.	56 mo.
9 R.T.	66	3	Yes	10 mo.	X-ray	18 mo.	28 mo.
10 F.Mc.	80	3	No	14 mo.	X-ray	12 mo.	26 mo.
11 Dr.R.	53	3	No	15 mo.	None	6 mo.	21 mo.
12 T.S.	39	3	No	6 mo.	1st: x-ray; 2nd: 9 mo. later laryngectomy	52 mo.†	67 mo.†
13 J.H.	54	3	Yes	22 mo.	X-ray	36 mo.	58 mo.‡

\* Died of other causes without evidence of recurrence of metastases.

† Alive and free of disease.

‡ Lost to follow-up fifty-eight months after treatment, without evidence of recurrence of metastases (living in foreign country).

rences in the extrinsic group, 4 received a second course of roentgen treatments. One of these patients survived a total of twelve years after irradiation and died of accidental illuminating gas asphyxiation at the age of seventy-six (Table v).

It is of interest to note that a total of 13 patients received a second course of intensive radiation for recurrence. In each case, the minimal dosage of the second

*dal tumor dose, or even a second similar course, when used in the selected case, will produce the undesirable complication of radionecrosis.*

Surgery following intensive roentgen irradiation is made slightly more difficult because of fibrosis. This, however, should never be the cause of hesitation or the cause for refusal to perform surgery. In the literature many statements have been made by

TABLE V  
ANALYSIS OF RECURRENCES IN EXTRINSIC GROUP TREATED  
INITIALLY BY ROENTGEN IRRADIATION

Case	Age	Histo- pathologic Grade	Metas- tases	Recurrence Time Irradia- tion in Months	Treatment of Recur- rence	Survival after Recurrence in Months	Total Survival Period in Months
1 C.A.	63	3	No	4	None	6	10
2 L.B.	60	4	No	46	X-ray	144	190*
3 J.Mc.	46	3	Yes	28	X-ray	5	33
4 T.W.	81	2	No	6	X-ray	1	7
5 G.K.	54	2	Yes	5	X-ray	2	7
6 P.L.	70	3	No	6	None	2	8

\* Died of accidental illuminating gas asphyxiation at age of seventy-six without evidence of recurrence or metastases.

course was about 3,000 roentgens, measured in air, delivered to each side of the neck. In this group sloughing of the laryngeal cartilages was observed in only one patient, and when last seen he was alive and free of disease five years after the initial treatment. If, therefore, irradiation, of itself, produces sloughing, this group certainly would have had the opportunity to demonstrate this fact. We have observed 2 other patients with sloughing of the laryngeal cartilages.<sup>1</sup> Both patients received only one course of roentgen irradiation. Sloughing of laryngeal cartilage is due, we feel, to the fact that the tumor has infiltrated the periosteum or has invaded the cartilage and bone itself. As the tumor regresses under irradiation, the cartilage and bone are exposed, infection of the cartilage and bone occurs and sloughing is then inevitable. Based on the above reported results and experiences to date, *we do not feel that one course of irradiation, delivering a cancerici-*

*prominent surgeons and laryngologists to the effect that surgery is very difficult after irradiation. Because of this some even refuse to perform the necessary surgery. I agree with the statement only in that irradiation makes the surgery more tedious and time consuming. Nowhere is this better demonstrated than in radical neck dissections following intensive irradiation for metastases.*

We feel that *recurrences after roentgen irradiation can be successfully treated by a second course of irradiation or by laryngectomy.* Recently, one patient with an intrinsic lesion was treated by laryngofissure for a recurrence two and one-half years following irradiation. This patient is now well and free of disease, two years after this procedure. Davis<sup>6</sup> reports 2 cases of recurrence after telerradium for intrinsic lesions, treated by laryngofissure and free of disease five years later. It must be cautioned that laryngofissure for a recurrence should never

be employed unless the lesion is small and does not extend beyond the involved cord.

#### RECURRENCES AFTER LARYNGECTOMY

In our experience, recurrence after laryngectomy is a hopeless condition. Fifteen patients with recurrences after laryngectomy were observed and treated and none survived. The average survival time in this group was nine and one-half months. In all cases in which irradiation was employed, a tumor dosage of about 6 to 10 threshold erythema doses was delivered. A temporary regression was observed in all cases; however, in two to four months recurrent activity was present. Some, in addition to the recurrence, developed metastases.

In a number of these cases we attempted to remove the recurrence surgically but without success. In other cases interstitial radon was implanted and external irradiation supplemented the surgical procedure, again without success. In more recent cases surgery alone has been utilized but so far the results have been discouraging. In one case, the pharynx and cervical esophagus were completely resected; several months later the patient developed a recurrence in the upper mediastinal portion of the esophagus and later developed metastases. It is my opinion that when a recurrence after laryngectomy is suspected, immediate extensive surgery is indicated. The surgical procedure will require a resection of the pharynx and cervical esophagus, combined with a partial neck dissection. If any success is to be attained in this group of cases, it will only be because of prompt radical surgery. For success it is most important that these recurrences are discovered early. The recurrence rate for laryngectomy is 24 per cent.

#### CRITERIA FOR SELECTION OF TREATMENT

When these statistics of recurrences are analyzed it becomes apparent that in addition to the recognized criteria,<sup>5,10,15</sup> it is necessary to consider the factor of possible recurrence and its prognosis in the selection

of the treatment procedure. The results of treatment by irradiation and laryngectomy, based on five year end-results and the recurrence rate for these procedures are about the same. The recurrence rate, as reported here, is 23 per cent for irradiation and 24 per cent for laryngectomy. The results reported in this paper show a hopeless prognosis for the treatment of a recurrence after laryngectomy. For a recurrence after laryngofissure or irradiation, the prognosis is not hopeless. In Table 1, out of 10 recurrences following laryngofissure, only 4 received additional treatment and 3 of these patients survived five or more years. Of 19 recurrences following irradiation (Tables IV and V), 14 received additional treatment. Five of these patients were living free of disease five years after treatment. Obviously, from the above facts it would appear that where the indicated procedure is irradiation or laryngectomy, radiation treatment should be given the preference. If, after the irradiation, a recurrence develops, such a patient still has the opportunity of successful treatment by laryngectomy.

These criteria are suggested as the basis for the selection of a method of treatment of cancer of the larynx.

1. The presence or absence of cervical metastases.
2. The location and extent of the lesion as evidenced by its appearance on direct and indirect laryngoscopy and by its appearance on lateral and planigraphic roentgen studies.
3. The motility and mobility of the lesion.
4. The histopathologic character of the lesion.
5. The general physical condition and temperament of the patient.
6. The probability of recurrence and prognosis for further treatment. (Recurrence rates: laryngofissure, 17 per cent; irradiation, 23 per cent; laryngectomy, 24 per cent. Treatment prognosis: recurrence after laryngofissure and irradiation, good; recur-

rence after laryngectomy, questionable.)

*Metastases* play an important part in selecting the treatment. Fortunately, only a small group of the cases of intrinsic cancer of the larynx develop metastases. In an analysis of 156 cases of intrinsic laryngeal cancer, only 13, or 8 per cent, have metastases on admission and another 16, or 10 per cent, developed metastases later in the course of the disease.

From a study of Table VI, it is obvious that patients with metastases have a very

TABLE VI

ANALYSIS OF TREATMENT OF CERVICAL METASTASES FROM CANCER OF LARYNX (1930-1941 inclusive)

Treatment	Cases	Dead of Disease	Dead of Other Causes	No Evidence of Disease
Roentgen irradiation	22	21	—	1*
Roentgen irradiation plus radon	1	1	—	—
Surgery	1	—	—	1
Combination of surgery, roentgen irradiation, and/or radon	7	3	1	3

\* Reticulum cell lymphosarcoma.

poor prognosis. When metastasis was present on admission, 1 out of 13 (8 per cent) survived five years. This patient had the metastatic lymph node removed at the time of the laryngectomy. The 4 patients treated by irradiation died.<sup>1</sup>

Prior to 1939 cervical metastases were treated exclusively by external irradiation. There were no survivals in this group. (Table VI). Since 1940 the treatment of cervical metastases in our clinic has been as follows: (1) For patients presenting metastases on admission, roentgen treatment is employed for treatment of the primary lesion in the larynx, and if possible, the metastases are incorporated in the same field. If not, an additional field is employed. Following the irradiation, either before the severe radiation epithelitis develops or after it has completely healed, the metastases are surgically exposed and

radon is implanted or a neck dissection with or without implantation of radon is performed. (2) For metastases occurring after the primary lesion has been controlled, a neck dissection with or without implantation of radon is performed. External irradiation is never used in the treatment of metastases in this group.

*The location and extent of disease* are especially important to evaluate in early cancer of the vocal cord. All cases where the lesion is limited to the cord itself or even involving the opposite cord without subglottic extension are best treated by laryngofissure, either by the clipping or anterior commissure techniques. In our clinic, we feel that cord lesions which are infiltrating or involving the thyroid cartilage or growths that are subglottic are best treated by laryngectomy. It must be admitted that some of these can be successfully treated by irradiation. Cutler<sup>5</sup> prefers to treat these by his so-called "concentration method." Our decision in this group of cases is based on observations of late complications that are apt to occur. It is in this group that radiation sloughing and "radiation laryngectomies" are likely to happen. The cartilage and bone, either tracheal, thyroid or cricoid, when infiltrated by tumor become exposed as the tumor tissue regresses and sloughs. This exposed cartilage is readily infected, resulting in a chondritis and osteomyelitis with subsequent sloughing. This type of complication, we feel, should be avoided whenever possible. In this type of lesion we occasionally see a patient die of sudden hemorrhage. All cases where the lesion is too extensive for laryngofissure and the above contraindications are not present, we feel should be treated by irradiation.

*When mobility of the laryngeal structure* is impaired or these structures are fixed, it is usually an indication of rather advanced disease and deep infiltration. This is seldom encountered in the intrinsic group but is frequently observed in the extrinsic cases. In these cases laryngectomy is the procedure of choice.

TABLE VII  
EVALUATION OF HISTOPATHOLOGIC GRADING AND METHOD OF TREATMENT  
OF SQUAMOUS CELL CARCINOMA  
(1930-1937 inclusive)

Grade 1					Grade 2			
Total Deter- minate Cases	Five Year Survival without Disease		Dead of Dis- ease		Total Deter- minate Cases	Five Year Survival without Disease		Recur- rence Treated by Other Means
13	13	100%	0	Laryngofissure	25	20	80%	1
7	5	71%	1	Laryngectomy	22	14	64%	—
1	1		0	Irradiation	15	9	60%	—
		95%		Net Five Year Survi- val Rate			70%	

When impairment or even fixation of one vocal cord occurs, it does not necessarily mean involvement of cartilage. This may occur either in cases of partial or complete cord destruction or where there is infiltration into the submucous tissues. We do not feel that these findings contraindicate irradiation. Impairment of cord motility is also observed where there is an inflammatory reaction coincident with the cancer. In these cases during irradiation the impairment diminishes or may completely disappear.

The histopathologic character of the lesion,

we feel, is of great significance in the selection of a treatment method. Results of radiation treatment in cancer of the larynx have shown conclusively that squamous cell carcinoma is radiosensitive and radio-curable.<sup>1,5</sup> Much can be said about the inadequacy of Broders' classification for grading; nevertheless, in our experience at Temple University Hospital the grading of tumors has been most helpful.<sup>2</sup> To date Grade 3 tumors treated by roentgen irradiation have given the poorest results (Table VIII). Squamous cell carcinoma, Grade 3, in our opinion, should not be treated by

TABLE VIII  
EVALUATION OF HISTOPATHOLOGIC GRADING AND METHOD OF TREATMENT  
OF SQUAMOUS CELL CARCINOMA  
(1930-1937)

Grade 3						Grade 4		
Total Deter- minate Cases	Five Year Survival without Disease		Dead of Disease	Recur- rence Treated by Other Means		Total Deter- minate Cases	Five Year Survival without Disease	Dead of Disease
17	11	65%	4	2	Laryngofissure	3	2	1
27	12	44%	15	—	Laryngectomy	—	—	—
15	4	27%	10	—	Irradiation	3	2	1
		46%			Net Five Year Survi- val Rate		67%	



irradiation, unless it is a very early lesion which is not suitable for laryngofissure, or other contraindications to surgery are present. Our experiences in recent years support this point of view. In squamous cell carcinoma, Grade 3, the results of laryngectomy and laryngofissure are superior to those of irradiation (Table VIII).

Squamous cell carcinoma, Grade 1, is not a radioresistant tumor.<sup>1</sup>

Up to 1940 three patients with a Grade 1 lesion were treated by irradiation. Two survived five years; one is living free of disease eight years after treatment and the other survived five years and was killed in a railroad accident. The third patient remained free of disease but died of Hodgkin's disease about one and a half years after treatment.

Squamous cell carcinoma, Grade 4, is radiosensitive and radiocurable.

#### SELECTION OF TREATMENT METHOD

The selection of the treatment method, surgery or irradiation, must not be made on a competitive basis but should be made for each patient after a thorough consideration of all factors above discussed. A perusal of recent literature reveals that most articles present results of one treatment modality, such as laryngofissure, laryngectomy or irradiation. *All three procedures have been shown to be effective in selected cases. There is no one method by which all cases of cancer of the larynx can or should be treated.*

At the Chevalier Jackson Bronchoscopic Clinic at Temple University Hospital, laryngofissure is employed in every case suitable for this procedure. If there is some contraindication to this surgical procedure or if the patient refuses this advice, then irradiation is advised. We agree with the proponents of irradiation that these cases would be most suitable for this treatment and the results might be equally as good as for laryngofissure. The fact remains that the operative procedure has an 80 to 85 per cent cure rate and we therefore feel it has definitely established itself and need

not be discarded in favor of irradiation at this time. When the statistics in this type of case have become sufficiently large to be of significance, then the treatment by laryngofissure or by irradiation will deserve re-evaluation.

The treatment modality can be safely selected on the basis of the following criteria and suggested treatment.

CRITERION	RECOMMENDED TREATMENT
1. <i>Metastases</i>	
a. Cervical metastases present	Irradiation to primary lesion Irradiation and/or surgery and/or radon
b. Cervical metastases absent	1. Laryngofissure 2. Laryngectomy 3. Irradiation
2. <i>Histopathology</i>	
a. Squamous cell carcinoma, Grade 1 and 2	1. Laryngofissure 2. Laryngectomy 3. Irradiation
b. Squamous cell carcinoma, Grade 3	1. Laryngofissure 2. Laryngectomy
c. Squamous cell carcinoma, Grade 4	1. Irradiation 2. In early cases limited to 3a, 3b, 3c, laryngofissure may be indicated
3. <i>Extent of Involvement</i>	
a. Growth limited to one cord not invading arytenoid or posterior commissure	Laryngofissure
b. Growth limited to anterior commissure and anterior third of each cord	1. Laryngofissure 2. Irradiation
c. Growth involving one cord ventricle	Laryngofissure
d. Subglottic extension	Laryngectomy
e. Growth involving anterior commissure, cord and base of epiglottis	Laryngectomy
f. Growth involving cord, aryepiglottic fold with limitation of motility	1. Irradiation 2. Laryngectomy
g. Growth involving posterior commissure, pyriform sinus, aryepiglottic fold and epiglottis, or party wall	1. Irradiation
4. <i>Motility and Mobility</i>	
a. Impaired motility of cord	1. Irradiation 2. Laryngectomy
b. Partial impairment of mobility of larynx	1. Laryngectomy 2. Irradiation
c. One side of larynx fixed or greatly impaired	Laryngectomy

CRITERION	RECOMMENDED TREATMENT
5. <i>General Factors</i>	
a. Presence of other disease contraindicating radical surgery	1. Irradiation 2. Laryngofissure
b. Temperament of patient—if patient cannot become adjusted to a laryngectomy	Irradiation

## SUMMARY

The results of the treatment of recurrences following laryngofissure, laryngectomy, and irradiation are presented and discussed. Recurrence after laryngofissure may be successfully treated by irradiation or laryngectomy. Recurrences following irradiation can be successfully treated by a second course of irradiation or laryngectomy. In an occasional selected case a laryngofissure may be indicated. The operative procedure is negligibly affected by previous irradiation. At the present time, recurrences following laryngectomy offer a hopeless prognosis.

Treatment of cervical metastasis may be divided into treatment of metastases on admission, and treatment of metastases occurring after the primary lesion has been controlled. When metastases are present on admission, the treatment is by irradiation, directed at the primary growth and the metastases. In addition, radon is implanted into the metastases or a partial or complete neck dissection may be performed. If the metastasis occurs after the primary growth has been controlled, the treatment is by neck dissection with or without the implantation of radon.

The criteria for the selection of treatment are discussed. The method of selection of the treatment modality in a given case of cancer of the larynx is presented. It is further suggested that a careful study of the results of treatment of recurrences will help greatly in evaluating the complex problem of selecting the modality in the initial treatment of cancer of the larynx. The results of this analysis indicate that laryngofissure and roentgen irradiation have an important role in the treatment of cancer of the larynx. Laryngectomy must

be reserved for the selected cases in which the above two procedures are contraindicated or have a poor prognosis, and also as an important procedure in the treatment of recurrence following laryngofissure and irradiation.

I wish to express my appreciation to Dr. A. E. Aegerter and to Dr. A. R. Peale of the Pathology Department, Temple University Hospital, for reviewing the histopathologic material reported in this study.

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#### DISCUSSION

DR. DOUGLAS QUICK, New York. Dr. Blady is dealing with a very trying and difficult group of cases—recurrent carcinoma of the larynx. I think he has a very versatile manner of approach and versatile mind in approaching it. I have just one thing to suggest. When one is charged with the responsibility of dealing with a growth that has already gotten out of hand there is little of basic responsibility for maintenance of tissues and maintenance of continuity of the airway. The first responsibility at that stage is the saving of life if possible. Consequently, if a destructive process is to be resorted to, or perhaps I should say, risked, I think it is better to use one that can be controlled rather than one that is apt to get somewhat out of control at times. In some of Dr. Blady's cases, therefore, it would seem to me perhaps safer to resort to the rather radical use of the cutting cautery of low intensity and then irradiating the fresh base rather than attempting to handle the entire situation by irradiation alone. If the growth can be controlled by such a combination of measures, plastic procedures will usually go a rather long way toward restoration of reasonable function.

DR. BLADY (closing). Dr. Quick, of course, suggests one of the correct procedures; that is, extensive fulguration or cautery removal of the tumor. In the neck it is not always possible to perform an extensive cautery removal of a recurrence such as would be indicated for a recurrence after laryngectomy. There are many vital structures in this region of the neck, and an extensive fulguration or cauterization could easily result in a fatality due to hemorrhage, mediastinitis or aspiration pneumonitis. These same complications may follow sloughing, which is a natural sequela of extensive fulguration.

In some of these cases we have considered doing a radical surgical excision with a resection of the sternum and placing the tracheotomy opening within the sternum itself. Such a procedure, although feasible, might not be well tolerated by the patient.

Dr. Leddy states that the cases of cancer of the larynx he sees are far advanced and inoper-

able and justifies the poor end results on this basis. At the Chevalier Jackson Bronchoscopic Clinic and the X-ray and Radium Therapy Department of Temple University Hospital we, too, see many of these far-advanced and inoperable cases. Some of the patients that we see have extensive ulcerated lesions, which have perforated through the skin. The fact that these lesions are inoperable does not mean that these patients should not be treated. Every patient should be given a chance, and we do not deny this chance to anyone even though in some cases this chance looks slim indeed. Naturally, there are not many salvages in this group of cases. In our end results we include all of the patients that we see, regardless of the state of the disease or the stage of operability. We treat every patient who comes to the clinic. Only those patients who are seen in consultation and are not treated by us are excluded from these statistics.

Many of our patients are in extremely poor nutritional state. It is necessary to have these patients hospitalized for supportive measures before the institution of treatment. They are given an adequate caloric, protein and carbohydrate intake along with adequate vitamin therapy and, if needed, blood transfusions and other intravenous medication. It is surprising how quickly these patients show improvement and can then be given the necessary treatment and can withstand the rigors of curative therapy, whether by surgery or by irradiation. Many of our patients, under this regimen, have gained weight in spite of the intensive radiation reaction on the skin and the mucous membranes, which follows after a cancer-lethal dose has been delivered to the tumor.

One of the discussors remarked that he was not in accord with such "dogmatic criteria" as were presented in this paper. It is unfortunate that in this age of progress we still find people relying on their infallible personal ability to judge what is the best treatment in a given case rather than to rely on criteria based on proved facts and end results.

During the past eight years we have carefully studied our patients. The relationship of various factors and end results of treatment by surgery and by irradiation were analyzed in an effort to determine whether any criteria could be established which would help in selecting the best treatment procedure in a case of cancer of the larynx. The criteria which are presented, we

feel, are pretty well founded on results obtained to date.

Now regarding the question of "placebo irradiation." I think that every patient, when he is first seen, should be given every opportunity of being cured. In other words, we should regard the treatment that is outlined as a curative procedure rather than as a "placebo". It is my opinion that "placebos" are something antiquated. They have no place in the present-day treatment of cancer of the larynx. We should in all cases, regardless of how hopeless the outlook may be, give that patient, if he so desires, a chance to be cured by treating him with the intent of curing. I could cite many instances where the unbelievable or miraculous result was obtained. Only recently we had the opportunity of seeing a patient who had extensive disease of the larynx with involvement of the laryngeal cartilage, a draining sinus in the skin and cervical metastasis. Because of this extensive disease and cervical metastasis, we did not feel that the patient should even be given the benefit of irradiation. Nevertheless, this was done. Later the metastasis was treated by neck dissection. For the past nine months the patient has been symptom free; clinically there has been no evidence of residual or recurrent disease, and he has been able to carry on his occupation.

Age likewise should be no deterrent in the treatment with intent to cure. Several years ago we treated a patient sixty-five years of age with the intention of primarily arresting the disease temporarily but not with the intention of curing, thinking that the amount of radiation to cure the lesion might be fatal to the patient. As a result, 2,500 roentgens, measured in air, were delivered to each side of the neck. A regression took place which lasted for about seven months. Again another course of treatment was given. Again there was regression. Finally, after about a year of this type of therapy, the recurrence was so extensive that nothing more could be done, and the patient died of the recurrent disease. In retrospect, I feel that an error of judgment was committed. This patient would have tolerated one course of intensive irradiation without much difficulty and might have been cured. Instead, it was necessary to give him several courses without giving him a chance of being cured. Since this experience, we treat all patients, regardless of age, with the intent to cure. We deliver a tumor dose that is cancericidal based on available scientific data.

I wish to thank Dr. Quick and the other participants for their interest and excellent discussion.



# THE STANDARDIZATION OF ROENTGENOGRAPHIC TUBES AND HIGH VOLTAGE CABLES\*

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SINCE the introduction of shockproof roentgenographic equipment several years ago, the roentgen-ray industry has been asked on a number of occasions to standardize the terminal design of its diagnostic tubes and high voltage cables so that the tubes and cables of one manufacturer might be freely interchangeable with those of another. The advantages of such standardization are evident. First, the maintenance and repair of roentgenographic apparatus would be greatly facilitated. Also, the production costs of roentgen-ray tubes and cables would be significantly lowered. And finally, the inventories of such extensive users of roentgenographic equipment as the Army, the Navy, the Veterans Administration, and the Public Health Service would be enormously reduced and their supply problems markedly simplified.

Until recently, the roentgen-ray industry has been somewhat reluctant to heed these requests, notwithstanding the advantages just cited. It has pointed out that if a standard terminal design were adopted, each manufacturer would be required to maintain a double inventory of tubes and cables for a period of several years to meet the service requirements of the roentgenographic equipment now in general use as well as the standard apparatus to be produced in the future. The industry also has indicated that the financial and engineering burdens placed on each manufacturer when converting to a new terminal construction are not insignificant.

The validity of the foregoing objections to a standardized terminal design cannot be disputed. However, these objections do not seem insurmountable nor do they appear to offset the advantages that would

accrue if the industry were to embark on a standardization program. Fortunately, the industry itself is now apparently inclined to discount the significance of its objections for within the past year it has decided to undertake the development of a standard terminal design which will permit the free interchange of the tubes and cables of one manufacturer with those of another. At the present time, the engineering staffs of the several manufacturers are collectively preparing plans for the new terminal and within the coming year the final design should be completed. The industry deserves the commendation of the profession for this far-sighted decision.

When the design of the new terminal was first undertaken, the industry was somewhat uncertain regarding the kilovoltage which the terminal should withstand. In recent years, several roentgenologists have expressed a desire for voltages in excess of the 100 kv. (peak) now generally available in roentgenographic equipment and the industry, feeling that this expression of opinion indicated a trend toward the routine use of higher voltages in diagnostic roentgenology, wished to have reliable data by which the upper limit of this trend might be estimated. It was stated that without such information the terminal design finally agreed upon might soon be obsolete.

Recognizing this problem, the Radiology Section of the Tuberculosis Control Division volunteered to investigate quantitatively in its laboratory the effect of roentgen tube potentials on the roentgenographic process and to make the resulting information available to the industry through the X-ray Technical Committee of the Na-

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tional Electric Manufacturers Association. The industry welcomed this gesture and late in 1945 the investigation was begun.

The study undertaken by the Radiology Section was divided into three phases: (a) an investigation of the effect of roentgen tube potentials on the clarity with which roentgenographic images may be visualized, (b) an investigation of the effect of roentgen tube potentials on the efficiency with which a roentgenographic machine operates, and (c) an investigation of the effect of roentgen tube potentials on the radiation dosage received by an individual during roentgenoscopy. It was thought that the quantitative data derived from such a comprehensive study would provide a reasonably satisfactory solution to the problem which confronted the industry.

A complete report of these investigations has been published.<sup>1</sup> Accordingly only a summary analysis will be given at the present time.

Roentgen tube potentials influence the clarity with which a roentgenographic image is recorded by affecting its contrast. As anticipated, it was found that roentgenographic contrast increases as tube potentials decrease, the effect being minimal for the images cast by soft tissues but quite considerable for the images of calcified structures. It appeared that with one possible exception the lowest roentgen tube voltage consistent with a reasonable exposure time will produce roentgenograms of optimum quality and that under almost all circumstances this voltage will be well below 100 kv. (peak). The one exception to this general rule is chest roentgenography. Here the use of tube potentials in excess of 100 kv. (peak) and the use of a grid permit the production of roentgenograms in which the shadows cast by the ribs do not obscure the images of the pulmonary structures.

The effect of roentgen tube potentials on the efficiency with which a roentgenographic machine operates is of particular

importance in photofluorography for under this condition the roentgen tube is frequently operated near its heat liberating capacity. It was found that the efficiency of roentgen-ray production varies almost proportionally with the voltage applied to the roentgen tube under conditions simulating those existing in photofluorography. That is, at 125 kv. (peak) 25 per cent more light is produced by the photofluorographic screen for a given amount of electrical energy consumed by the roentgen tube than that occurring at 100 kv. (peak). Although this gain in efficiency is not spectacular, it nevertheless is sufficient to demand careful consideration.

In regard to the effect of roentgen tube potentials on the radiation dosage received by the skin of a patient during roentgenoscopy, it was found that for a given screen brightness the dosage decreases slowly as the roentgen tube potential is increased until it reaches a minimum at a voltage of approximately 120 kv. (peak). Thereafter the dosage increases slightly. The exact voltage at which minimum dosage occurs depends on the size of the field under examination, the thickness of the anatomical structure and other similar factors. However, this voltage does not deviate significantly from 120 kv. (peak) through a wide range of conditions.

After careful consideration of the foregoing data the roentgen-ray industry decided that it should design its standard tube and cable terminal to withstand potentials sufficient to permit the operation of diagnostic roentgen tubes at 125 kv. (peak). Since these tubes are customarily operated under conditions in which ground potential is midway between the anode and cathode potentials, the terminal therefore will have a nominal rating of 62.5 kv. (peak) (i.e.,  $\frac{1}{2}$  of 125 kv. (peak)). In making this choice, the industry pointed out that it believes that most diagnostic roentgenology will continue to be performed at voltages considerably below 100 kv. (peak). However, since there likely will be occasions when many roentgenologists may wish to work

<sup>1</sup> Morgan, R. H. Roentgen tube potentials in diagnostic roentgenology. *AM. J. ROENTGENOL. & RAD. THERAPY*, August, 1947, 58, 211-221.

at higher potentials, the industry thought it wise to provide the standard terminal with the highest possible rating within the limits of economic expediency. The new terminal will permit the roentgenologist to work with voltages at which his patients will be subjected to a minimum radiation dosage during roentgenoscopy, with voltages at which his photofluorographic equipment may be operated at a substantially greater efficiency than has heretofore been possible and with voltages at which many new and improved techniques, particularly in the field of chest roentgenography, may be developed. Furthermore, the voltages provided by the new terminal will require no significant change in the design of present day roentgen generators. Thus, generators equipped with the standard terminal will not differ significantly in size or cost from those now available.

It has been decided that the cathode and anode terminals will be of identical design. Furthermore, the terminals used in roentgen-ray tubes will be identical to those used in roentgen generators. It therefore will be possible for service organizations to make all replacements of defective high voltage cables with a single cable type in the future. Cable inventories will thereby be reduced to an absolute minimum.

At the present time plans for the size and shape of the terminal are being prepared. When these are completed the terminal will be ready for general adoption by the industry. It is not anticipated that when this time comes there will be a simultaneous industry-wide conversion to the new terminal. The relative inflexibility of production schedules and the problems of post-war reconversion preclude such a program. Instead it is planned that each manufacturer will adopt the new terminal at a time that seems most expedient to do so. Undoubtedly some manufacturers will convert to the new terminal immediately. Others, however, will likely do so only after several months have elapsed.

It is gratifying to observe the progressive attitude taken by the roentgen-ray indus-

try in this development. Indeed there is every reason to believe that other programs of standardization will be undertaken before long. It is generally recognized, for example, that much would be gained by standardizing such items as valve tubes and their terminals and the mounting devices of roentgen-ray tubes. Let us hope that the industry will continue its fine work until the needless multiplicity of designs that now exist in many pieces of roentgenographic equipment is completely eliminated.

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#### DISCUSSION

DR. PAUL C. HODGES, Chicago, Ill. The advantages of complete standardization of cables, valve tubes and roentgen tubes are so obvious that they need no argument. In fact, the only objection that can be raised to standardization is the contention that it will be costly and temporarily inconvenient. But the contention is unsound and, as a matter of fact, it is lack of standardization that is costly and wasteful and the waste hurts us as individuals even though it is government money that is being spent or money from our own gross income which can be deducted from our income tax as an expense.

We radiologists could, if we would, apply the pressure necessary to assure standardization but the ones who will probably actually do it are the government agencies that have to buy this material in such large quantities. However if it is done, we radiologists will benefit when standardization is accomplished.

DR. LAURISTON S. TAYLOR, Washington, D. C. As a person very closely associated with this whole problem of standardization, I certainly want to congratulate Dr. Morgan, Dr. Hodges and their coworkers for their energy in having brought about this very desirable situation in the standardization of roentgen tubes and cables. That subject has been discussed by various groups for almost as long as cables have been in use.

Any problem of standardization is difficult. Each manufacturer will start out to produce a device which according to his manufacturing problems appears to him to be the most economical, to have the best sale value and to put

him in a proper competitive position on the market. That is, of course, very proper.

It is necessary, however, as things come into general use, to make a real attempt to avoid a large multiplicity of parts. This is particularly true and particularly important in any portion of the roentgen equipment which is subject to wear or which is subject to complete usage.

At the start of any standardization program, in a commercial standardization program, there are naturally going to be certain costs to the manufacturer above his ordinary manufacturing program. Don't anybody be deceived. The user will pay those costs. On the other hand, if a user stays a user long enough, he will surely receive the benefit of ultimately lower costs which will in all probability wipe out the higher initial costs.

It was mentioned that the standardization of cables would simplify servicing questions, particularly in the Army and Navy and Veterans Bureau. There is no question about that, and the government is attempting to standardize numerous other items in order to simplify what is at the present time a tremendously complicated government procurement program.

There is another person who will benefit very much by this program and that is the small user. There are a great many radiologists in isolated places. They may have a piece of equipment that is supplied by a company who doesn't have a service man to go five hundred miles for his particular equipment. If something goes wrong and he is out of commission for a few days the patients suffer and he suffers. If it is possible for him to go to anybody's stock and get a replacement part, such as a cable, naturally his efficiency of operation is going to be greatly improved.

Dr. Morgan mentioned the question of standardization of other items. I think, myself, that two of the most important items to be standardized in the future are roentgen tubes and valve rectifiers. Those two points were mentioned. At the present time, one frequently has great difficulty in getting a replacement tube when he wants it and where he wants it.

Standardization in this field ought to be no more difficult ultimately than the standardization of an electric light bulb. You can imagine our difficulties if we had half a dozen different types of sockets or the states passed their own rules as to what kind of a socket one would

have. We have almost that situation now in the x-ray field.

There is one other point which isn't exactly in the way of standardization of material, but nevertheless which does in my opinion offer a field for unification, at least. That is in the descriptive ratings of roentgen-ray equipment. At the present time, roentgen-ray equipment carries a name plate. It may say as much as 220 volts, 60 cycles on a plate. It is a very rare thing indeed for it to say anything more. It is perfectly feasible and it is highly desirable, in my opinion, that roentgen-ray transformers, tubes, cables, glass, all sorts of items of that sort be properly labeled with standardized labels in such a way that anybody at any time can tell exactly what he has on his hands.

The work can be carried further, not exactly into standardization of a specific item but in standardization of methods of ratings. For example, at the present time, when one wishes to compare roentgen films put out by two manufacturers, he is very much at the mercy of the manufacturer as to how he can compare the film of one manufacturer with that of another.

I don't know that there are any standard, recognized schemes at the present time for describing the necessary qualities of roentgen films. Similarly, for roentgen fluorescent screens, intensifying screens, and quite a number of other items. I think it would be inadvisable, on the other hand, to attempt standardization of such things as transformers, timers, shutters, and so on. Those questions have been brought up but I think that their standardization, as we know it at the present time, is probably undesirable.

One must always bear in mind that standardization, if done carelessly, will unquestionably stifle development. The important thing is to have the manufacturers operate through an organization in which they have membership so that they can get together and discuss these problems so that the radiological societies can approach the organization and present their problems. Such an organization does exist in the National Electric Manufacturers Association and I think Dr. Morgan and his people have done an excellent job in presenting some of the radiological problems to this group and arousing the interest and activity of the manufacturers.

DR. MORGAN (closing). There is just one thing that I would like to say in closing. The



roentgen-ray industry is planning a meeting for the final freezing of its designs later this month. and I think that now would be a good time to extend an invitation to many of you, as radiologists, to write to me and express your opinions as to your particular likes and dislikes regarding various designs with which you have worked in the past.

Although as a radiologist, I have tried to visualize as many of the problems as possible that you are facing day in and day out and have tried to include in the recommendations the things that you would naturally think of, it is unlikely that all of the ideas that should be incorporated in the standard cable design have been included.



# COMPARATIVE VALUE OF DEEP AND SUPER-VOLTAGE ROENTGEN THERAPY\*

## STATISTICAL ANALYSIS OF FIVE YEAR RESULTS IN SELECTED GROUPS

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FIFTEEN years have now elapsed since the introduction of supervoltage roentgen therapy in the treatment of cancer and therefore it may appear advisable to try to estimate, on the basis of all available data, whether or not such a method has justified itself sufficiently to become part of our daily radiologic practice.

The physical investigations<sup>4,6,9,10,13</sup> demonstrated that supervoltage roentgen therapy has a definite advantage over deep roentgen therapy for at least three reasons: (1) it permits the administration of a certain physical dose to cancer with less effect on the skin; (2) because of the greater depth dose and the lesser attenuation of the beam it makes possible a more homogeneous irradiation, especially of large volumes of tissue, and (3) it permits a simplification of the technique of irradiation by reducing the number of portals necessary for the purpose of crossfiring.

Early publications seemed to indicate that there is an advantage also from the clinical point of view.<sup>7,9,15</sup> It appeared that localized deep-seated cancers were being treated more efficiently with supervoltage roentgen therapy than with deep roentgen therapy. The general reactions were less, the patients recovered more rapidly and the percentage of immediate results had been definitely raised. However, as time went on, the analysis of the late results revealed a somewhat different picture. Some investigators found that the good initial response was followed not infrequently by permanent cures, but others were disappointed to see that this objective had not been fulfilled.

### REVIEW OF THE LITERATURE

Schmitz and Sheehan,<sup>11</sup> in 1941, published the five year survivals in a group of 26 cases of carcinoma of the cervix uteri treated by supervoltage roentgen therapy at Mercy Hospital, Chicago, and were able to show that 46.1 per cent of the patients were cured. In a later report from the same institution<sup>12</sup> the observation was extended to 72 cases, of which 37.5 per cent remained well after five years. This represented a very distinct improvement in favor of supervoltage roentgen therapy as compared to the former results obtained with deep roentgen therapy. A similar improvement was described by Kamperman<sup>5</sup> in most gynecologic cancers.

Colby and Schulz<sup>1</sup> in 1943 reported on a total of 139 cases of neoplasms of the bladder treated by supervoltage roentgen therapy over a period of five years at the Collis P. Huntington Memorial Hospital and Massachusetts General Hospital. In these cases supervoltage roentgen therapy was given as an accessory method to other standard procedures. By calculating from the time of the onset of the disease, 40 per cent of the cases were alive after four years as compared to 20 per cent prior to the institution of supervoltage roentgen therapy, and 15 per cent of untreated cases. Later, Holmes and Schulz<sup>3</sup> added another 57 cases of vesical carcinoma, all inoperable, in which supervoltage roentgen therapy constituted the most important part of the treatment, although radium implantation and fulguration were also used. In these latter cases the five year survival curve has fallen short of the expectation,

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amounting to only about 10 per cent. Phillips<sup>9</sup> reported on several groups of cases treated at St. Bartholomew's Hospital, London, and he noted definite improvement in carcinoma of the cervix, carcinoma of the larynx and especially carcinoma of the rectum.

On the other hand, Watson and Urban<sup>14</sup> found that supervoltage roentgen therapy produced only a palliative effect of very short duration in a series of 63 cases of intrathoracic cancer treated at Memorial Hospital, New York. Hocker and Guttman<sup>2</sup> have likewise given a discouraging account of 315 cases of carcinoma of various locations which were treated from August, 1939, to February, 1943 at the same institution. They state, however, that in nearly half of the cases, the disease was so advanced that palliation was all that could be expected from the beginning.

Very recently, Holmes and Schulz<sup>3</sup> in an excellent article have reviewed 1,835 cases of malignant neoplasms of all locations treated with supervoltage roentgen therapy at the Collis P. Huntington Memorial Hospital from 1937 through 1941 and at the Massachusetts General Hospital from 1940 through 1944. They state that in addition to the cutaneous advantage and the good immediate palliation a slight but definite increase in life expectancy was noted when the cases were properly chosen. Although more information is necessary before final conclusions can be drawn, they feel that the method should be encouraged in selected cases of carcinoma of the cervix, carcinoma of the bladder, carcinoma of the lung, embryoma of the testicle, carcinoma of the tonsil, localized lymphoma, Ewing's tumor and carcinoma of the rectum.

Because of this paucity of material, it may not be out of place to bring up to date the five year results in selected groups of cancer as obtained at Harper Hospital, Detroit, where supervoltage roentgen therapy has been employed routinely since 1933. The report is to some extent a continuation of a similar one published in 1940<sup>8</sup> and also embodies most of the gynecologic cases referred to by Kamperman.<sup>5</sup>

## MATERIAL

The present study is based on a series of 1,888 cases treated from 1923 to 1940 inclusive, of which 1,038 received deep roentgen therapy and 850 supervoltage roentgen therapy. To obtain better comparable data the series is divided into lots of five years. The first lot includes the cases treated from 1923 to 1927, the second lot from 1928 to 1932, the third lot from 1933 to 1937 and the fourth lot from 1938 to 1940. In the first two lots deep roentgen therapy was used. The effect of the technical improvement of the irradiation with the passage of time is evidenced in the slight increase of the results of the second lot as compared to the first in practically all groups. In the third lot from one-third to one-half of the cases were treated by deep roentgen therapy and the remainder by supervoltage roentgen therapy. In the fourth lot supervoltage roentgen therapy was used almost exclusively.

In view of the fact that an over-all comparison is aimed at, no attempt was made to eliminate any cases. During the early days of supervoltage roentgen therapy, for example, many cases which proved refractory to deep roentgen therapy were subsequently treated with supervoltage roentgen therapy and, as is now known, no worthwhile improvements in the results may be expected in such instances. Yet, all these cases were included in the supervoltage roentgen therapy group. Likewise, radium-fast cases, especially of gynecologic cancer, repeatedly treated afterward with deep or supervoltage roentgen therapy are included in their respective groups. Even if the malignancy had reached such an advanced stage of development that irradiation could serve temporary palliation at best, or if the contemplated treatment for some reason could not be carried to conclusion, the case was not omitted. In this manner the figures obtained represent absolute values.

In estimating the permanency of the results, the five year survivals were taken into consideration. The untraced cases showed a variation of from 0 to 5 per cent

for the different years. They were all temporarily included among the dead so that by the time a 100 per cent follow-up is reached, the figures for certain years will change slightly for the better.

The factors of irradiation have remained in the main the same, except for improvements in the technique of procedure. The deep roentgen therapy was carried out with 200 kv. (peak), 1.5 mm. Cu, 1 mm. Al, half-value layer 1.9 mm. Cu, and an intensity of 20 r per minute at 50 cm. skin target distance. The factors of supervoltage roentgen therapy were: 500 kv. (constant), 7 mm. Cu, 3 mm. Al, 3 mm. celluloid, half-value layer 9 mm. Cu, and an intensity of 20 r per minute at 60 cm. skin target distance. When the technique of irradiation was changed, a more or less similar method was used for both types of roentgen rays.

#### SELECTED GROUPS OF CASES

Since physical measurements show that the greater value of supervoltage roentgen therapy in relation to deep roentgen therapy lies chiefly in a better distribution of the radiation within a given volume of tissue, it was thought advisable to select for the purpose of comparison lesions of such locations of the body that bring this advantage to the forefront in a maximum degree. Two good examples in this respect are the neck and the pelvis. The former is a slender part of the body with a transverse diameter of only 8 to 16 cm. so that a relatively large tissue dose can easily be administered with both types of roentgen rays. The latter constitutes a part of much wider dimensions and therefore the administration of a certain tumor dose necessitates crossfiring through a number of portals. On theoretical and physical grounds supervoltage roentgen therapy, because of a greater depth dose, would seem to possess here a definite advantage. The lesions chosen and their relative incidences are given in Table I.

(1) *Carcinoma of the Tongue.* This lesion is included since the prognosis in the vast majority of the cases depends upon the

extension to the lymph nodes of the neck and since the primary focus itself is located in a terrain so difficult to irradiate. In lot 1 the percentage of regional metastases to the neck at the time of the institution of treatment amounted to 88 per cent, in lot 2 to 70 per cent, in lot 3 to 68 per cent and in lot 4 to 76 per cent. The treatment consisted in protracted fractionated irradiation

TABLE I

SELECTED GROUPS OF CARCINOMA OF VARIOUS  
LOCATIONS TREATED FROM 1923 TO 1940

Total Cases			
Carcinoma of	Deep Roentgen Therapy	Super- voltage Roentgen Therapy	Total Cases
Tongue	69	47	116
Larynx	44	55	99
Thyroid	36	42	78
Cervix uteri	512	367	879
Fundus uteri	66	95	161
Ovary	140	102	242
Rectum	98	55	153
Bladder	73	87	160
TOTAL	1,038	850	1,888

of the oral cavity and neck with the addition of interstitial radium, cautery or surgical excision of the primary focus. The results indicate no difference between deep roentgen therapy and supervoltage roentgen therapy, except in lot 3 where there is a slight improvement in favor of supervoltage roentgen therapy (Table II).

(2) *Carcinoma of the Larynx.* It must be stated that at the beginning of the series only the inoperable cases of carcinoma of the larynx were referred for radiation therapy. Therefore the treatment consisted of fractionated protracted irradiation, without any other accessory method. In a few instances emergency tracheotomy had to be performed during the course of the irradiation. In later years, a combination of surgery and radiation therapy was used more often. This change of procedure

TABLE II  
FIVE YEAR SURVIVALS IN CARCINOMA OF TONGUE

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	5	—	—	1933	6	1	17	—	—	—
1924	5	—	—	1934	—	—	—	2	1	50
1925	8	—	—	1935	—	—	—	5	1	20
1926	5	—	—	1936	4	—	—	6	2	33
1927	9	—	—	1937	—	—	—	3	1	33
TOTAL	32	—	—		10	1	10	16	5	31
1928	2	—	—	1938	2	—	—	4	1	25
1929	6	1	17	1939	—	—	—	12	—	—
1930	6	1	17	1940	—	—	—	15	3	20
1931	7	1	14							
1932	5	1	20							
TOTAL	26	4	15		2	—	—	31	4	13

reflects to a certain extent on the results obtained, but, even so, it appears that the introduction of supervoltage roentgen therapy has produced some improvement (Table III).

(3) *Carcinoma of the Thyroid*. The results in carcinoma of the thyroid have remained practically the same throughout

the entire series. The five year survivals amounted to about 40 per cent irrespective of whether the irradiation was carried out with deep or supervoltage roentgen rays (Table IV). A combination of surgery and radiation therapy was used extensively whenever possible.

(4) *Carcinoma of the Cervix Uteri*. In this

TABLE III  
FIVE YEAR SURVIVALS IN CARCINOMA OF LARYNX

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	—	—	1933	—	—	—	3	—	—
1924	3	1	33	1934	—	—	—	10	2	20
1925	2	—	—	1935	—	—	—	10	2	20
1926	3	—	—	1936	5	—	—	1	—	—
1927	3	—	—	1937	3	—	—	2	—	—
TOTAL	15	1	7		8	—	—	26	4	15
1928	4	—	—	1938	—	—	—	7	4	57
1929	2	—	—	1939	—	—	—	14	4	29
1930	4	—	—	1940	—	—	—	8	2	25
1931	6	—	—							
1932	5	—	—							
TOTAL	21	—	—		—	—	—	29	10	30

TABLE IV

FIVE YEAR SURVIVALS IN CARCINOMA OF THYROID

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	2	50	1933	3	1	33	3	2	66
1924	3	1	33	1934	—	—	—	2	1	50
1925	5	2	40	1935	—	—	—	6	3	50
1926	2	1	50	1936	2	—	—	2	—	—
1927	4	2	50	1937	—	—	—	3	1	33
TOTAL	18	8	44		5	1	20	16	7	44
1928	1	1	100	1938	—	—	—	12	4	33
1929	—	—	—	1939	—	—	—	7	3	43
1930	4	2	50	1940	—	—	—	7	3	43
1931	3	1	33							
1932	5	1	20							
TOTAL	13	5	38		—	—	—	26	10	40

group, the method of treatment was changed several times. The cases of lot 1 were treated by hysterectomy and post-operative roentgen therapy when found operable and by intracavitary radium and deep roentgen therapy when diagnosed as inoperable. Since 1928 the operation, except in rare instances, has been completely abandoned and all cases subjected to intracavitary radium and external roentgen therapy. The main method remained the intracavitary radium, the dose being raised to the uppermost limit of tolerance. Roentgen therapy was used to make up for the deficiency of the dose, especially toward the periphery of the pelvis. The rationale of

TABLE V

FIVE YEAR SURVIVALS IN CARCINOMA OF CERVIX UTERI

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	58	9	16	1933	28	6	22	22	11	50
1924	49	8	16	1934	26	6	23	31	16	52
1925	40	8	20	1935	26	5	19	35	12	34
1926	41	3	7	1936	12	1	8	51	16	31
1927	38	5	13	1937	—	—	—	49	22	45
TOTAL	226	33	15		92	18	20	188	77	40
1928	45	10	22	1938	—	—	—	54	14	26
1929	48	10	21	1939	—	—	—	56	21	38
1930	28	6	22	1940	—	—	—	69	29	40
1931	37	7	19							
1932	36	8	22							
TOTAL	194	41	21		—	—	—	179	64	36

TABLE VI  
FIVE YEAR SURVIVALS IN CARCINOMA OF FUNDUS UTERI

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	—	—	—	1933	4	1	25	2	1	50
1924	2	1	50	1934	3	—	—	3	3	100
1925	3	1	33	1935	3	2	66	9	3	33
1926	7	2	29	1936	2	1	50	9	6	66
1927	6	2	33	1937	1	—	—	12	6	50
TOTAL	18	6	33		13	4	30	35	19	50
1928	1	—	—	1938	—	—	—	20	10	50
1929	7	2	29	1939	—	—	—	20	9	45
1930	4	3	75	1940	—	—	—	20	10	50
1931	11	5	45							
1932	12	5	42							
TOTAL	35	15	43		—	—	—	60	29	48

this procedure was not modified by introducing supervoltage roentgen therapy. Thus the only difference in lots 2, 3 and 4 is the fact that the deep roentgen therapy was gradually replaced by supervoltage roentgen therapy. As shown in Table v, the five year survivals with deep roentgen therapy in lots 2 and 3 amounted to about

20 per cent, whereas with supervoltage roentgen therapy in lots 3 and 4 they were practically doubled.

(5) *Carcinoma of the Fundus Uteri*. In this group, a combination of hysterectomy and irradiation was used in the operable cases throughout the series. In lot 1 hysterectomy was carried out first and ir-

TABLE VII  
FIVE YEAR SURVIVALS IN CARCINOMA OF OVARY

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	4	—	—	1933	15	2	13	11	2	18
1924	11	3	27	1934	10	1	10	7	2	28
1925	9	2	22	1935	9	1	11	7	—	—
1926	7	—	—	1936	1	1	100	11	2	18
1927	10	2	20	1937	1	1	100	16	6	38
TOTAL	41	7	17		36	6	17	52	12	23
1928	14	3	21	1938	—	—	—	25	6	24
1929	13	1	8	1939	—	—	—	13	6	46
1930	11	4	36	1940	—	—	—	12	4	33
1931	12	1	8							
1932	13	2	15							
TOTAL	63	11	17		—	—	—	50	16	32

TABLE VIII  
FIVE YEAR SURVIVALS IN CARCINOMA OF RECTUM

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	11	1	9	1933	6	—	—	4	2	50
1924	10	1	10	1934	5	—	—	4	1	25
1925	8	1	12	1935	2	1	1	8	3	37
1926	2	—	—	1936	4	—	—	8	2	25
1927	7	1	14	1937	4	1	25	3	1	33
TOTAL	38	4	11		21	2	10	27	9	33
1928	9	—	—	1938	—	—	—	8	2	25
1929	7	—	—	1939	—	—	—	10	1	10
1930	7	1	14	1940	—	—	—	10	2	20
1931	9	1	11							
1932	7	1	14							
TOTAL	39	3	8		—	—	—	28	5	18

radiation applied in the form of deep roentgen therapy postoperatively. Since 1928, however, a course of intracavitary radium and external roentgen therapy has been undertaken first and the hysterectomy performed six weeks later. A second course of roentgen therapy was then given within two or three weeks after the hysterectomy. In the inoperable cases, a combination of intracavitary radium and external roentgen therapy has been used from the beginning. In lots 3 and 4 deep roentgen therapy was gradually replaced by supervoltage roentgen therapy for all cases. As is seen in Table VI this resulted in an increase of the five year survivals

TABLE IX  
FIVE YEAR SURVIVALS IN CARCINOMA OF BLADDER

Years	Deep Roentgen Therapy			Years	Deep Roentgen Therapy			Supervoltage Roentgen Therapy		
	Cases	Well	Per Cent		Cases	Well	Per Cent	Cases	Well	Per Cent
1923	5	1	20	1933	4	1	25	2	1	50
1924	9	2	22	1934	2	—	—	5	1	20
1925	5	—	—	1935	2	1	50	4	1	25
1926	8	1	12	1936	1	—	—	10	2	20
1927	5	1	20	1937	7	1	14	12	3	25
TOTAL	32	5	16		16	3	19	33	8	24
1928	5	1	20	1938	—	—	—	27	8	30
1929	5	1	20	1939	—	—	—	8	1	12
1930	7	2	29	1940	—	—	—	19	5	26
1931	4	1	25							
1932	4	1	25							
TOTAL	25	6	24		—	—	—	54	14	26



from 40 per cent to about 50 per cent for the total group. The fact that more than half of the carcinomas of the fundus uteri are in the operable stage explains the relatively high percentage of the five year survivals with deep roentgen therapy and the lesser increase as compared to the cervix uteri when changing to supervoltage roentgen therapy.

(6) *Carcinoma of the Ovary*. The generally accepted method of combining surgery with roentgen therapy has been used in carcinoma of the ovary throughout the series. It is quite remarkable that with deep roentgen therapy the five year survivals in lots 1, 2 and 3 as shown in Table VII were uniformly 17 per cent. The introduction of supervoltage roentgen therapy first appeared to barely change the situation but in lot 4 the five year survivals rose to 32 per cent.

(7) *Carcinoma of the Rectum*. The cases of carcinoma of the rectum referred for radiation therapy were invariably of the inoperable or recurrent type. In a limited number a combination of intracavitary radium, or cautery and external roentgen therapy was used but the vast majority of them were treated by roentgen therapy alone. With deep roentgen rays the five year survivals, as is seen in Table VIII, amounted to about 10 per cent; with supervoltage roentgen rays to from 18 to 33 per cent.

(8) *Carcinoma of the Bladder*. A slight increase in the results was obtained also in carcinoma of the bladder. Table IX shows that for the deep roentgen therapy group the five year survivals represented about 20 per cent, whereas for the supervoltage roentgen therapy group they rose to 25 per cent.

#### SUMMARY AND CONCLUSION

In summarizing these results it appears that the assumptions based on theoretical considerations and physical measurements are now being substantiated by long range clinical observations. There can be no doubt about the fact that supervoltage

roentgen therapy leads to considerably less damage to the skin than deep roentgen therapy. This may not be of great importance if life is prolonged only for a short while but when a permanent result can be secured in an increasing number of cases it is desirable that the skin be saved as much as possible.

As concerns the therapeutic efficiency on the tumor the only difference between deep roentgen therapy and supervoltage roentgen therapy is that the latter permits a better irradiation. There is no direct quality dependence in the sense that certain malignant neoplasms that fail to respond to deep roentgen therapy could be destroyed by supervoltage roentgen therapy. Therefore, no attempt should be made to replace well established methods, as for example association of surgery and roentgen therapy or a combination of radium and roentgen therapy by the sole use of supervoltage roentgen therapy expecting to improve the final results. Even in the inoperable cases, some accessory therapeutic method may become necessary after supervoltage roentgen therapy has helped create a more favorable situation. In this manner the role of supervoltage roentgen therapy runs parallel to that of deep roentgen therapy. However, by making possible a more efficient treatment in the selected case it will lead, especially in the presence of localized tumors which are seated in large volumes of tissue, to a definite increase in the final results.

The conclusion may be drawn, therefore, from a review of the literature and the data presented in this study, that supervoltage roentgen therapy is of noteworthy value in properly selected cases. It constitutes a desirable addition to our future radiotherapeutic armamentarium.

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## DISCUSSION

DR. U. V. PORTMANN, Cleveland, Ohio. Dr. Leucutia has presented an interesting comparison of the results he has obtained with deep and supervoltage roentgen therapy. He is well qualified to do so after fifteen years of experience and being meticulous in the technique of administration and careful in clinical judgment and observation. His conclusions are properly conservative.

His presentation supports contentions that any improvement of supervoltage over deep roentgen therapy must be due to more homogeneous radiation and relatively greater depth dose because of more forward and less back scattered radiation with increasing voltages and filtration. In other words, the improvement must be physical and quantitative rather than biological or qualitative. This has been manifest since deep roentgen therapy superseded lower voltage roentgen treatment.

It has been the experience of Dr. Leucutia and others employing supervoltage roentgen therapy that a high proportion of cases so treated are in advanced stages of disease. The results in such cases, of course, would be disappointing and should not be compared with the results with other methods of treatment for cases with less extensive involvement. In judging the results it is necessary to take two factors into consideration. First, in radiation therapy we will always be confronted with biological factors influencing variations in radiosensitivity of tumors and, in addition, relative differences in radiosensitivity between neoplastic and normal tissues. Second, the fact that neoplastic cells may migrate from primary tumors to remote parts of the body, and though the primary tumor may be eliminated by irradiation, this will not affect metastases outside the area treated. Therefore, it is folly to expect to cure all patients with either radioresistant or radiosensitive tumors in any location when metastases are present or widely distributed, no matter what quality of roentgen rays may be available.

Dr. Leucutia has presented three logical advantages of supervoltage over deep roentgen therapy. These are based on purely physical and

technical factors. These advantages and his improved results further support the thesis that the effects of radiation on tissues are quantitative rather than qualitative. Also, he has properly stated that "supervoltage roentgen therapy is of noteworthy value" and cannot supplant but must supplement other methods such as radium therapy and surgery for the treatment of malignant diseases.

The most important factor governing curability of malignant tumors in any location will always be the anatomical extent of involvement at the time treatment is instituted. It is to be hoped that Dr. Leucutia and others will some time compare the results of deep and supervoltage roentgen therapy in series of cases classified or grouped on such a basis rather than only according to organs primarily affected.



# THE EFFECT OF ROENTGEN RAYS ON THE IN VITRO MOTILITY OF FELINE INTESTINE\*

By BRADFORD N. CRAVER, M.D.

SUMMIT, NEW JERSEY

THIS paper reports experiments designed to elucidate the possible effect of roentgen-ray exposure in vitro on the motility of isolated strips of small intestine from the cat. Goldhaber and Back<sup>1</sup> in 1941 published an interesting series of in vitro experiments designed to determine the minimal dose of roentgen rays which would: (1) stop the beating of myocardial fragments from seven day old chick embryos; (2) stop the movements of intestinal strips from eighteen day old chick embryos, and (3) stop the ciliary activity of *Buffo viridis*. The minimal doses required ranged from 500,000 to 1,000,000 r, respectively. This report, which but recently came to our attention, summarizes the few previous studies of the effect of roentgen and  $\gamma$ -irradiation on the kinetic activity of cells and tissues in vitro. Those studies reported no changes. Only the experiments reported by Scott,<sup>2</sup> however, included studies made a sufficient number of days after exposure to allow for a latent period which might obtain before any effects became evident. He reported that the auricles of *Rana esculenta* exposed continuously to the unmeasured radiation from 5 mg. of radium in the form of radium bromide showed no significant contractile differences from the controls for six days or more after exposure. The heart, however, is notoriously resistant to the effects of irradiation,<sup>2</sup> whereas the intestine is known to be very sensitive and for this reason the present study was undertaken.

## METHOD AND RESULTS

Five cats were employed in this study. All cats were killed after light anesthesia with sodium pentobarbital by opening the chest. The jejunum and ileum were removed for the experiments, carefully

washed out with previously oxygenated ice-cold Locke's solution, divided into six approximately equal and consecutively numbered segments, with exceptions as noted, beginning with the proximal or jejunal end, and then stored in the refrigerator between layers of cotton soaked in oxygenated, cold Locke's solution. The technical irradiation factors in these experiments were: 120 kv., 8 ma., 7.5 inches target skin distance, output 640 r per minute. No filter was used save that inherent in the instrument. In a preliminary experiment the intestine of the first cat was exposed to 1,000 r two days after the intestine had been removed from the animal. Immediately thereafter a strip of jejunum and one of ileum were placed in continuously oxygenated, isolated, 100 cc. tissue baths at 39° C. and their longitudinal contractions kymographically recorded for over four hours by which time their activity had markedly diminished. The resulting records after comparison with previously secured controls suggested some stimulation of the contractile mechanism. The intestine of the second cat was divided into four equal segments, the first exposed to 2,000 r with the second kept as an unexposed control, the third exposed to 5,000 r with the fourth retained as an unexposed control. Immediately after exposure a strip of the segment exposed to 2,000 r and a contiguous strip from its control segment were arranged for kymographic recording and the longitudinal contractions recorded for 7.5 hours. No significant differences in the behavior of the two strips, either in respect to the type or over-all duration of the contractions, were observed. Three days after exposure three strips from the segment that received 5,000 r and three strips

\* This paper is based on work performed under Contract Number W-7401-eng-49 with the Manhattan Project for the University of Rochester, Rochester, New York.

from its control segment were arranged in the previously described fashion, but again no significant differences were noted. The intestines of the last three cats were all treated as follows: Segment No. 1 was exposed to 1,000 r with No. 2 kept as control; segment No. 3 to 5,000 r with No. 4 as control; and segment No. 5 to 10,000 r with No. 6 as control. Kymographic recordings for 1.5 hours were secured immediately after exposure for one strip taken from the proximal end of each of the six segments and the same procedure was followed on each of the succeeding three days. No significant differences between the behavior of the exposed and the control strips were noted. The motility on the first day was excellent, on the second good, on the third fair, and on the fourth poor. The latent period between the placing of the strip in the bath and the onset of spontaneous motility varied from seconds on the first day to twenty to thirty minutes on the fourth, but in all respects the exposed and unexposed strips behaved similarly.

#### DISCUSSION

The doses of roentgen rays employed did not have any apparent effect on the contractile mechanism of the small intestine of the cat. The first experiment, inadequately controlled it is true, would suggest that roentgen-ray exposure of the small intes-

tine two days after its removal from the animal might augment its action, although this putative action was probably illusory. Unfortunately, circumstances did not at the time permit the experiments required to settle this point. The results are consistent with Henshaw's views.<sup>3</sup>

#### SUMMARY

The exposure in vitro to doses of soft roentgen rays, varying from 1,000 to 10,000 r, of strips of small intestine from the cat did not appear to influence significantly their kymographically recorded motility.

The author thanks Mr. Robert Hay and Mr. Herbert Mermagen for arranging the roentgenologic exposures and Miss Mildred Taylor for technical assistance.

556 Morris Ave.  
Summit. N. J.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Committee on Arrangements:* To be appointed.

*Thirtieth Annual Meeting:* 1948, to be announced.

# EDITORIAL

## CANCER OF THE STOMACH

ACCORDING to Dr. Parran, Surgeon General of the United States Public Health Service, during the four years of World War II the American Armed Forces lost 300,000 men as a result of enemy action. During the same period an identical number of persons died from cancer of the digestive system, accounting for about 45 per cent of all cancer deaths in the United States. In one-third of these the cancer involved the stomach.

A lesion which still takes such a large toll of life merits our most earnest consideration. It is therefore very fortunate that periodical conferences dealing with gastric cancer are being arranged under the auspices of the National Advisory Cancer Council. The proceedings of the third conference were published recently.<sup>1</sup>

A perusal of the wealth of material reveals that the attack on this one of the most fatal diseases is conducted in various ways.

From the therapeutic standpoint the best attack, of course, continues to remain surgery. A very definite progress has been made during the past decade. Pack, who has contributed so notably toward the improvement of the surgical technique, states that the better end-results in gastric cancer may be attributed, among other things, to the introduction of extremely radical operative procedures such as total gastrectomy, transthoracic cardiectomy and removal of organs adjacent to the stomach that are involved by contiguity with the cancer. Although the immediate postoperative mortality may be greater than for the simple subtotal gastrectomy, the percentage of end-results is undoubtedly increased.

Radiation therapy, either as a primary agent in the inoperable cases or as an adjunct to surgery in the operable group, has a limited value. It seems that nothing significant has been added to what is already more or less generally accepted.

In the domain of research, however, considerable progress has been made and the Conference has dealt with several problems of great interest. Thus Strong gave further evidence to strengthen his conclusion, formerly arrived at, that hereditary cancer in mice can be induced by chemical means. For some time it was observed that gastric carcinoma and other types of neoplasia and hyperplasia occurred in mice following the subcutaneous injection of methylcholanthrene dissolved in sesame oil and that untreated descendants of such mice continued to develop similar lesions spontaneously. Strong now assumes that the manifold lesions arising just anterior to the pylorus in mice are biologically related and most probably are due to the process of hybridization, on the one hand, and to the induction of gene mutations by methylcholanthrene or one of its metabolites, on the other. This observation is the more remarkable since, as is known, gastric carcinoma is very rare in lower animals as contrasted with the high incidence in humans. The mice of Strong were studied histologically by McPeak and Warren who found that the microscopic characteristics of these gastric lesions are not altogether sufficient to permit an exact classification into benign or malignant tumors, a fact which somewhat complicates the issue. Lushbaugh performed a series of experiments on monkeys to determine if any damage resulted to the lungs from oil fogs used to screen Army personnel from enemy

<sup>1</sup> Conference on Gastric Cancer. *J. Nat. Cancer Inst.*, 1947, 7: 299-385.

observation and he accidentally noted that the monkeys developed a fatal gastric lesion. A given percentage of the monkeys died during or shortly after the 100 day exposure period. On necropsy hyperplastic gastritis, polyps and penetration of the submucosa by epithelial growths were observed due probably to the ingestion of a considerable quantity of oil. This oil was later found to be exceedingly rich in substances giving the absorptive spectra of carcinogenic hydrocarbons.

One of the monkeys described by Lushbaugh was killed one and one-half years later and postmortem examination revealed the presence of a severe atrophic gastritis. For a long time gastric atrophy had been assumed to be a late stage of hyperplastic gastritis and this observation seemed to prove it. The process, as a rule, was considered irreversible. Benedict, however, after a review of the literature on gastric atrophy and based on his own personal observations arrived at a somewhat different conclusion. He distinguishes between a localized and diffuse gastric atrophy. The former may occur in conjunction with ulcer and cancer or may be mixed with a chronic hypertrophic gastritis. The latter may be idiopathic or may be observed in association with deficiency diseases, notably pernicious anemia. Although pathologic evidence is as yet lacking, Benedict was able to confirm by gastroscopy that in some cases prolonged, intensive liver therapy resulted in definite improvement of the gastric atrophy. The well known high incidence of gastric tumors, especially in the diffuse atrophy of the mucosa of the stomach, was borne out in Benedict's series. Furthermore an unusually high incidence of tumor formations was found in other parts of the body.

Ivy and Cooke attempted to produce experimentally malignant transformation of gastric ulcer in rabbits. They used domestic and wild brown rabbits for this purpose. The ulcer was produced by excising part of the gastric mucosa. As a rule, such procedure leads in rabbits to the formation of

a chronic callous ulcer with papillomatous overgrowth of the mucosal edge. To induce malignant degeneration methylcholanthrene was given daily per os. No detectable change of the ulcer was found in the domestic rabbits from three and one-half to five and one-half months postoperatively but epithelial cysts formed in three of the four wild rabbits after five to thirteen months.

The results of some other experimental investigations are also interesting, although their meaning is not as yet clear. Schiff and his co-workers found, for example, that if tracer doses of radioactive iodine are given the stomach concentrates this substance to a considerable degree and that the salivary glands excrete the radioactive iodine even in higher concentration than the stomach. Kelsey and Brunschwig, on the other hand, noted a selective capacity of the gastrointestinal cancers to concentrate quinine given either by mouth or by vein.

However important these experimental investigations may be in their scientific scope, obviously for the time being they can have but little influence on the practical aspect of improvement of the final results in cancer of the stomach. Therefore, as in the past, our only hope must remain in the establishment of an early diagnosis and if possible in the proper identification of the likely precursors of gastric cancer.

The question arose whether or not the introduction of some routine survey method, such as now successfully practiced in chest examinations, may not be of greater aid. Rigler and Kaplan have spent considerable time in trying to elaborate such a system but the difficulties encountered were considerable. Morbidity statistics show that only 3 out of 1,000 persons over forty years of age are apt to be afflicted with carcinoma of the stomach at any one time. A complete examination, therefore, by means of roentgenoscopy, spot roentgenograms and serial roentgenography of all asymptomatic individuals of the cancer-bearing age would be an ex-



pensive and time-consuming procedure which could not be utilized on a large scale. According to these investigators a better purpose is served by selecting the patients for routine periodic examinations on the basis of some precursory disease, lesion or symptom known to be associated with gastric carcinoma more frequently than in the general population.

Rigler and Kaplan in performing regular semi-annual roentgen examinations at the University of Minnesota Hospital in all patients with pernicious anemia found a rather high incidence of benign and malignant epithelial tumors of the stomach as compared to the paucity of gastric tumors detected in non-selective mass surveys. The investigations were gradually extended to other likely precursors of gastric carcinoma. State, Varco and Wangenstein of the same institution are carrying out at the present large-scale surveys on (1) patients over fifty years of age with histamine achlor-

hydria and hypochlorhydria, (2) patients with gastric polyp, (3) patients with pernicious anemia, and (4) relatives of patients with gastric carcinoma. It is also planned to investigate patients with atrophy of the lingual mucosa and/or severe pyrorrhea alveolaris as potential developers of gastric carcinoma.

Rigler and Kaplan suggest that for large-scale examinations some method of rapid photofluorography or cineroentgenography be seriously considered.

By introducing simpler procedures and by establishing properly selected groups of individuals to be examined it is hoped that through periodically repeated examinations cancer of the stomach may be detected at an earlier asymptomatic stage of the disease. This then would permit treatment under more favorable conditions, leading to an improvement of the final results.

T. LEUCUTIA



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF THE ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Haddon Hall, Atlantic City, N. J., Sept. 16-19, 1947.

#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Chicago, Ill., 1948.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21-25, 1948.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

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#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### LOUISVILLE RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

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#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

## NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. O. A. Neely, 924 Sharp Bldg., Lincoln, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

## NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

## NEW HAMPSHIRE ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

## NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

## NORTH CAROLINA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

## NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

## OHIO STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland. Meets during meeting of Ohio State Medical Association in Cincinnati, May, 1948.

## OKLAHOMA STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

## ORLEANS PARISH RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

## PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

*Secretary*, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

## PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport.

## PHILADELPHIA ROENTGEN RAY SOCIETY

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*Secretary*, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

## PORTLAND ROENTGEN CLUB

*Secretary*, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

## RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

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## RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

## RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

## RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

## RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, New-

ark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

## ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

## ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary*, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

## ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

## SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

## SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

## SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

## SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

## SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

## TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

## TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGEN-  
OLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

## UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

## UTAH RADIOLOGICAL CONFERENCE

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

## UTAH STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

## VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

## WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University

Hospital, and second six months at Toland Hall, University of California Hospital.

## CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA  
*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

## BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY  
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)  
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES  
*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION  
*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS  
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION  
*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA  
*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA  
*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

## CONTINENTAL EUROPE

SOCIÉTÉ BELGE DE RADIOLOGIE  
*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE  
*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

POLISH SOCIETY OF RADIOLOGY  
First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY  
*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE  
*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.  
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.  
*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY  
*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY  
*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES  
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA  
*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)  
*Secretary* for French language, Dr. Babaiantz, Geneva.  
*Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

## AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will conduct its 29th Annual Session at San Francisco, California, April 19-23, 1948. General Headquarters will be at the Civic Auditorium. Dr. William J. Kerr and Dr.

Ernest H. Falconer, both of San Francisco, are the Co-Chairmen for local arrangements and the program of Clinics and Panel Discussions. The President of the College, Dr. Hugh J. Morgan, Professor of Medicine at Vanderbilt University School

of Medicine, Nashville, Tennessee, is in charge of the program of Morning Lectures and afternoon General Sessions.

Secretaries of medical societies are especially asked to note these dates and, in arranging meeting dates of their societies, to avoid conflicts with the meeting of the College, for obvious mutual benefits.

#### RESEARCH FELLOWSHIPS—AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians announces that a limited number of Fellowships in Medicine will be available from July 1, 1948–June 30, 1949. These Fellowships are designed to provide an opportunity for research training either in the basic medical sciences or in the application of these sciences to clinical investigation. They are for the benefit of physicians who are in the early stages of their preparation for a teaching and investigative career in Internal Medicine. Assurance must be provided that the applicant will be acceptable in the laboratory or clinic of his choice and that he will be provided with the facilities necessary for the proper pursuit of his work. The stipend will be from \$2,200 to \$3,000.

Application forms will be supplied on request to The American College of Physicians, 4200 Pine Street, Philadelphia 4, Pa., and must be submitted in duplicate not later than November 1, 1947. Announcement of the awards will be made as promptly as is possible.

#### SECTION ON RADIOLOGY

##### AMERICAN MEDICAL ASSOCIATION

The American Medical Association will hold its 1948 annual session in Chicago, Illinois, June 21–25. Those wishing to present papers before the Section on Radiology should communicate with the Secretary of the Section, Dr. U. V. Portmann, 2020 East 93d St., Cleveland 6, Ohio, before December 1, 1947.

#### ATOMIC RADIATIONS UNIT

Formation of an Atomic Radiations Unit in the Chemical Section of the Industrial

Hygiene Division, United States Public Health Service, was announced by Dr. J. G. Townsend, Chief of the Division. Duncan Holaday, Engineer (R), is in charge of the new Unit.

The new Unit will advise and assist State industrial hygiene units in detecting and evaluating health hazards produced by the use of radioactive isotopes and high energy machines such as roentgen-ray machines and betatrons.

Radioactive isotopes are used primarily in scientific research. Roentgen rays are increasingly used in industry for the inspection of finished products. Fluoroscopes are fairly commonly used in the citrus fruit, tobacco, and retail shoe industries.

It is believed that institutions and industries are handicapped in their desire to use radioactive isotopes and high energy machines by their lack of information about the safe handling of dangerous quantities of radioactive materials. The new Atomic Radiations Unit, working through industrial units in the States, will help institutions and industries evaluate their hazards and establish safe working conditions.

#### AMERICAN RADIUM SOCIETY

The Twenty-ninth Annual Meeting of the American Radium Society was held at the Seaside Hotel, Atlantic City, New Jersey, on June 9 and 10, 1947, the President, Dr. Charles L. Martin of Dallas, Texas, presiding. Several excellent symposia were presented on the radiation treatment of various types of cancer and in due course of time these papers will be published in this JOURNAL.

The following officers were elected for the year 1947–1948: *President*, Dr. A. N. Arneson, St. Louis, Missouri; *President-Elect*, Dr. Maurice Lenz, New York; *First Vice-President*, Dr. William S. MacComb, New York; *Second Vice-President*, Dr. Leland R. Cowan, Salt Lake City, Utah; *Treasurer*, Dr. Howard B. Hunt, Omaha, Nebraska; *Secretary*, Dr. Hugh F. Hare, Boston, Massachusetts; *Member of the Executive Committee*, Dr. Charles L. Martin, Dallas, Texas.

The Thirtieth Annual Meeting of the Society will be held in Chicago, Illinois, in 1948. The place and dates will be announced later, as soon as the information is available.

Hugh F. Hare, *Secretary*

#### AMERICAN COLLEGE OF RADIOLOGY

At the Twenty-third Annual Meeting of the American College of Radiology held at Atlantic City, New Jersey, on June 8, 1947, the following officers were elected for the year 1947-1948: *President*, Dr. E. C. Ernst, St. Louis, Missouri; *Vice-President*, Dr. Charles L. Martin, Dallas, Texas; *Treasurer*, Dr. Warren W. Furey, Chicago, Illinois; *Secretary*, Mac F. Cahal, Chicago, Illinois.

The Twenty-fourth Annual Meeting of the College will be held in Chicago, Illinois, at the Continental Hotel on June 20, 1948.

#### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

At the meeting of the Rocky Mountain Radiological Society held in Denver, Colorado, August 7-9, 1947, the following officers were elected for the coming year: *President*, Dr. James P. Kerby, Salt Lake City, Utah; *President-Elect*, Dr. Howard B. Hunt, Omaha, Nebraska; *First Vice-President*, Dr. Q. B., Coray, Salt Lake City, Utah; *Second Vice-President*, Dr. E. M. Hayden, Tucson, Arizona; *Secretary-Treasurer*, Dr. M. D. Frazer, Lincoln, Nebraska; *Historian*, Dr. John S. Bouslog, Denver, Colorado.

The recent meeting was a successful one, with over 165 registrants. The guest speakers were Dr. Lloyd F. Craver, Kenneth E. Corrigan, Ph.D., Dr. Eldwin R. Witwer, Dr. Claude Hunt, Dr. Leo G. Rigler, Dr. Lowell S. Goin and Dr. Edgar P. McNamee.

The next annual meeting, in 1948, will be held in Salt Lake City, Utah.

Maurice D. Frazer, *Secretary*

#### OHIO STATE RADIOLOGICAL SOCIETY

At the recent meeting of the Ohio State Radiological Society the following officers were elected for the coming year: *President*, Dr. Ralph W. Holmes, Chillicothe; *Vice-President*, Dr. Henry Snow, Dayton; *Secretary-Treasurer*, Dr. Carroll C. Dundon, Cleveland; *Executive Committee*, Dr. H. F. Fulton, Columbus and Dr. E. C. Elsey, Cincinnati.

The next meeting of the Society will be held in conjunction with the meeting of the Ohio State Medical Association in Cincinnati in May, 1948.

#### To The Editor:

Page xii of the advertising section of the July, 1947, issue of the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY contains an advertisement announcing a grid front cassette and designated by the manufacturer as "Lysholm Grid Cassette" without any connotation as to the origin of the device. This grid cassette combination was devised by myself and we have been using two experimental models for nearly a year. It seems to have many uses and visiting radiologists have expressed interest in it. It was my understanding with the manufacturer, who also expressed an interest, that no announcement concerning the device would be made until my description of the cassette and its applications were published in a scientific journal. The terminology "Lysholm Grid Cassette" is technically correct since in that particular model a metal Lysholm grid is used as was in my original model. However, the designation implies that the device was originated by Lysholm which is not correct. For the sake of the record and my own interest in the matter, which is certainly not material, your readers might be interested in this clarification.

JOHN D. CAMP, M.D.

Mayo Clinic,  
Rochester, Minnesota

## BOOK REVIEWS

*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

**RADIUM LOST AND FOUND.** By Robert B. Taft, M.D., B.S., M.A., F.A.C.R. Second edition. With an introduction by George E. Pfahler, M.D., Sc.D., LL.D., D.M.R.E. (Camb.), F.A.C.R. Cloth. Pp. 158, with 27 illustrations by Mercedes Hoshall, B.F.A. Charleston, S. C.: Walker, Evans & Cogswell Co., 1946.

Dr. Taft has reorganized and enlarged the fascinating story of lost and found radium which he first told eight years ago. The material in the new book is based upon years of experience by the author and many of his friends in hunting lost radium. The book is again dedicated "To That Mythical Little Animal of Unknown Origin, the Radium Hound." It will undoubtedly find interested readers in this atom-conscious age. Investigators using radioactive isotopes as tracers will admire the labors of their forefathers who for many years have traced lost radium, long before the atom bomb was ever heard of, by ingeniously combining a detective's skill with the expert handling of various detectors of radioactivity. These detectors were originally a photographic plate and a fluorescent screen, then gold leaf electrosopes and string electrometers which in turn around the thirties were replaced by sensitive Geiger counters. Around that time the author of the book had built a very compact, battery-operated counter for the special purpose of finding lost radium.

Radium tracing expeditions usually start in the room where the loss of radium has occurred or has first been noticed; they lead through elevators, chutes or stairways to trash disposal piles, incinerators, laundries, sewers, city dumps, even to farms where city ashes have been dumped on driveways or where city garbage has been fed to hogs. Taft describes numerous such radium hunts and most of them read like detective stories rather than sober scientific experiments. At the end of many long successful searches, radium was found in a living pig ("complete recovery of radium, complete loss of pig"), in the base of a bedpan hopper, in the lace of a patient's dress, in the needle holder of a phonograph, in deep mud under a boat, under new cement sidewalks, in a

sewage disposal plant, in laundry vats, on trucks en route to the city dump, and many other unusual places. Most losses occur when bandages containing radium are removed from patients and thrown by accident into refuse receptacles whence they are carried to the incinerator or the dump. The longer the time interval between loss and start of search the smaller the chance for recovery. Although accurate statistics on radium losses are not available, Taft reports 187 losses of radium with 115 recoveries, 16 partial recoveries, 53 total losses and three unknown results. Although radium has been appropriated because of the attractive appearance of its metal containers or occasionally lost under suspicious circumstances, there is apparently no authenticated case in which radium was a stolen for a profit motive. An interesting chapter on damage to radium containers by accidental breakage or spontaneous explosions and an appendix discussing the construction of the author's portable Geiger counter complete this most fascinating story of radium lost and found.

OTTO GLASSER

**QUEENSLAND RADIUM INSTITUTE, QUEENSLAND, AUSTRALIA.** Second Annual Report of the Honourable the Minister for Health and Home Affairs. For the Year ended 30th June, 1946. Pp. 23.

Although this center is called a Radium Institute, facilities for treatment with radium and roentgen rays are available. In Queensland, according to this report, one person in four is expected to have cancer; this incidence is about fifteen times the incidence of cancer in European countries. This enormous difference is largely due to a much greater prevalence of skin cancer. Eighty-two per cent of the population of Queensland live along the East coast of this province, and 24 per cent live in a tropical climate. Of "old patients" treated only a small proportion are said to be afflicted with recurrences; the greater number is made up of patients who present new lesions of the skin. It is not unusual to see patients who have been treated over the years for fifty or more malig-

nant conditions of the skin. During 1945, out of a total population of 1,052,000, 1094 persons died of cancer; fifty-one persons died of skin cancer.

The Institute, which occupies a wing of the Brisbane Hospital, has five sub-centers situated at Mater Hospital (Brisbane), Rockhampton (396 miles), Mackay (598 miles), Townsville (832 miles), and Cairns (1043 miles).

For cutaneous neoplasms (basal and squamous cell) of the torso or lower extremity, surgery is sometimes advised, but for most malignant lesions of the skin radiation treatment is employed. The kind of treatment varies according to the site, size, depth, extent and pathologic character of the lesions. Multiple lesions may require combined treatment (roentgen rays, implantation of radium, radon mould and radium plates). For primary melanoblastomas surgery is advised, and for inoperable extension to lymph nodes palliative roentgen treatment is employed. In skin cancer early treatment is emphasized. For epithelioma of the lip radium implantation is preferred, only superficial lesions being subjected to contact treatment with roentgen rays. As soon as the primary lesion has healed, affected tributary lymph nodes are excised en bloc. When these show rapid growth, roentgen treatment is used to check growth pending surgery. "Prophylactic" irradiation has been discarded.

For epithelioma of the tongue and floor of the mouth implantation of radon seeds rather than radium needles is preferred (average tumor dose 6000 r). Block dissection of involved lymph nodes is recommended; when an inoperable mass of nodes is present, implantation of radium or radon, with or without roentgen treatment, is employed. In cancer of the breast the rate of survival has been disappointing.

In chronic myeloid leukemia exposure of the entire body is favored when radioactive phosphorus is not available; this is combined with local irradiation of the spleen, when this organ is large. In chronic lymphatic leukemia, masses of nodes and the spleen are treated, and sometimes this is supplemented by roentgen treatment of the trunk through large fields. Radioactive phosphorus, when available, has been used in some cases of lymphosarcoma, leukemia and polycythemia vera; the results have been similar to those obtained with roentgen rays.

A. U. DESJARDINS

**MEDICAL RESEARCH: A SYMPOSIUM.** Edited by Austin Smith, M.D. Cloth. Price, \$5.00. Pp. 169, with 17 illustrations, including 10 in color. Philadelphia: J. B. Lippincott Company, 1946.

This small volume, written by eight men, discusses the various angles of medical investigation. The eight chapters deal with Fundamentals of Medical Research, Some Practical Aspects of Research, The Laboratory, The Manufacture and the Development of New Drugs, Medical Research in the University Medical School, Clinical Research with a Notebook, The Publicizing of Scientific Research, and Photography in Medical Research.

The outstanding contribution is written by Thorald Sollman, Dean Emeritus of Western Reserve University School of Medicine. This is an epitomized statement of his views based on many years of medical research and in association with others in this field. The chapter dealing with The Relation of Photography to Medical Research by Milton C. Bohrod and H. Lou Gibson is stimulating and contains some of the finest colored photographs illustrating medical topics which have been published.

This book should be of interest to some students of medicine or the medical sciences, to those of the non-medical public who desire to learn more about research in general, and to anyone who contemplates entering this field of human endeavor.

CYRUS C. STURGIS

**A MEMOIR TO THE ACADEMY OF SCIENCES AT PARIS ON A NEW USE OF SULPHURIC ETHER.** By W. T. G. Morton of Boston in the U.S.A. Presented by M. Arago in the Autumn of 1847. Paper. Price, \$1.50. Pp. 24. New York: Henry Schuman, 1946.

This reprint, one of the most important of Morton's statements concerning his first public demonstration of ether with special reference to the relation of various other claimants to the origination of the fundamental concept, is of absorbing interest to those who have not the privilege of reading or owning one of the rare original copies. The credit for no other great discovery in the fields of medicine or science has ever been more confused and obscured than that of anesthesia. Its story has often been told as a romance, as a case for the jurist, as a congressional debate and as theatrical and impassioned personal claims. We have long since acknowl-



edged anesthesia as one of science's greatest gifts to humanity. We owe it to our sense of truth and fairness to read the original statements of Morton written by him in the heat of controversy in defense of his own achievements.

Morton's first publication on anesthesia was his "Remarks on the Proper Mode of Administration of Sulphuric Ether by Inhalation" which was issued in Boston in September, 1847. In November, 1847, Morton published in Paris a memoir in French addressed to the Academy of Sciences at Paris, an account of the ether controversy. In a calm and dignified manner he states his claims in relation to the events and to those of Wells and Jackson.

This statement was issued in English in *Littell's Living Age* in March, 1848. It represents the fullest and most complete account of the whole event in relation to all persons and circumstances involved and is fundamental in every consideration of the facts of this all important event. There is a foreword by John F. Fulton that is introductory and explanatory, part of which is recapitulated in this review. This brochure reprinted by Schuman will be of interest to all those not so fortunate as to have the rare original, but who do have an interest in one of the important landmarks of medical progress.

FREDERICK A. COLLIER

*JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES*. Vol. 1, No. 4, 1946. Anesthesia Centennial Number. Paper. Price, \$2.50. Pp. 505-710, with illustrations. New York. Henry Schuman, 1946.

This issue of a new and important journal marks two anniversaries; the first of the Journal, and the one hundredth of the public administration of ether. The volume is worthy of both. Twenty-two articles are presented, all of them developing the historical backgrounds of anesthesia from differing viewpoints in a complementary fashion. It is impossible in a short review to enumerate and analyze each presenta-

tion but one can say that every paper is original and based on research that advances our knowledge rather than reiterates the facts that have become commonplace through past repetition.

An original and important aspect of the symposium is the inclusion of a number of studies of the original use of anesthesia in many countries about which the English medical literature has been silent. This issue of the Journal synchronized as it was with the celebration of the Centenary of the Public Administration of Ether at the Massachusetts General Hospital and because of its own importance is a volume that could well be bound alone as a work of fundamental worth in any medical library. The praise of this single issue is understated for those interested in medical historical material since the various presentations will become important as primary contributions to the history of one of medicine's most vivid achievements.

Aside from a most laudatory mention of this anniversary number of the Journal it is not beyond the scope of this review to draw attention of anyone who may read this to the Journal itself. A quarterly, now in its second year, it is already an important, attractive, and basic medium for the presentation of medical history in its broadest aspect. Mr. Schuman is to be congratulated upon his concept and I suspect his courage in attempting the production of a cultural rather than a practical venture. Doctor Rosen and his distinguished associate editors and consulting staff are to be praised for their efforts to carry on a journal devoted to the growth of the Health Sciences from earliest times to the present. In our professional lives we emphasize the practical. As we do so we tend to become static or to retrogress. It is only by a continuing study of our past that we will avoid the evils of practicality and advance as our works warrant.

Everyone interested in the past of medicine and in its future progress is urged to subscribe to and enjoy the authoritative and fascinating contents of the *Journal of the History of Medicine and the Allied Sciences*.

FREDERICK A. COLLIER



## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

### A SIMPLE MOTORIZED ATTACHMENT FOR TOMOGRAPHY\*

By ALLAN HURST, M.D., and A. S. WAINHOUSE, R.T.  
DENVER, COLORADO

**T**OMOGRAPHY in chest diseases is now a well established diagnostic procedure in most tuberculosis hospitals and sanatoria. The original model of the roentgen-ray attachment was worked by a string arrangement or by manually moving the cassette in one direction and the tube in

the opposite direction. The objections to this technique were: (a) exposure of the technician to a high dosage of roentgen rays; (b) lack of uniformity in the speed of movement of the tube. A third but minor objection was need for an additional switch to the control stand, or an extra technician

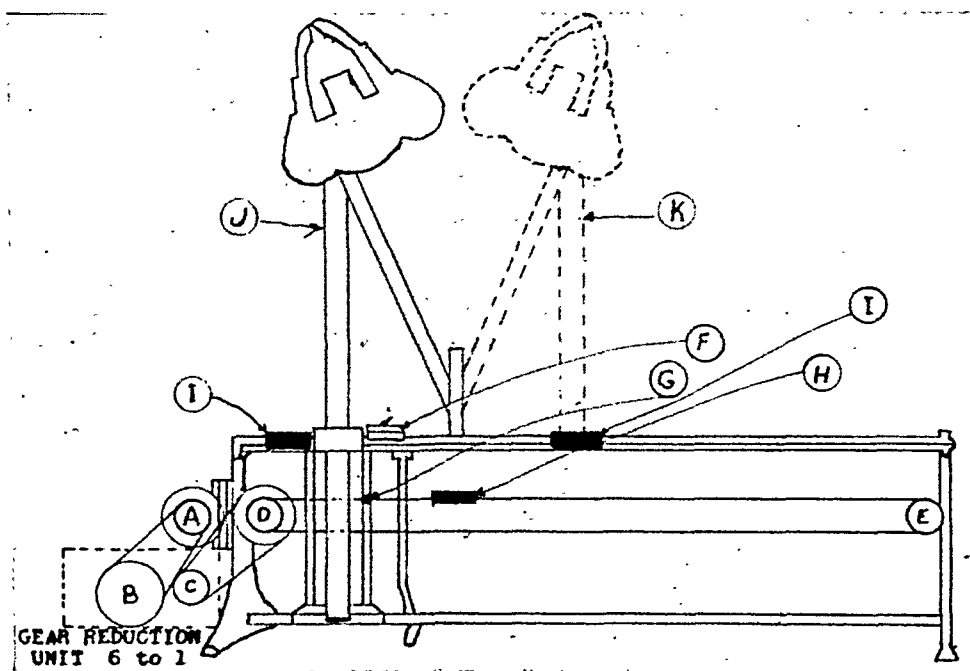


FIG. 1. A,  $\frac{1}{4}$  HP. G. E. motor 115 V single phase 1725 RPM—pulley and V-belt drive to (B). B, input pulley (fast) of 6 to 1 gear reduction unit—V-belt drive to (A). C, output pulley (slow) of 6 to 1 gear reduction unit—V-belt drive to (D). D, jackshaft with V-belt pulley and steel cable pulley—V-belt drive to (C); cable drive to (E). E, idler pulley for steel cable—cable drive from (D). F, switch box mounted on tube stand locking device on tube column. G, hook and lug for attaching cable to column. H, turnbuckle for taking up the stretch of the steel cable. I, cams (2) for operating "limit" switches for travel limits. J, position of tube at the beginning of planigraph travel. K, position of tube at end of the planigraph travel.  
A sheet metal hood covers A-B-C-D for protection of the operator; a sheet metal hood covers E.

\* From the National Jewish Hospital at Denver, and the University of Colorado School of Medicine.

to operate the controls while the tube and cassette were being moved.

Because of these difficulties the roentgen technicians took as few tomograms as possible, and the staff was reluctant to utilize this diagnostic procedure to its fullest extent.

Careful investigations were made into the feasibility of motorization of the equipment. The drawing (Fig. 1) illustrates the installation of a  $\frac{1}{4}$  H.P. motor and cables, which is operated very easily by the technician at the control stand. The tube and cassette can be moved in only one direction at this time, but additional equipment may be added to move it in both directions.

The ease and simplicity of operation has increased the number of tomograms taken at this hospital. The technique has not been changed, and the distance of tube from patient is still calculated in the same way. To our best knowledge this is the simplest motorized equipment for tomography other than the larger elaborate machine which takes planar roentgenograms in all directions.

National Jewish Hospital  
Denver 6, Colo.

We are indebted to the General Electric X-ray Corporation and especially to their Denver office for help in designing the motorized unit.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

LIST, CARL F., and HODGES, FRED J. Intracranial angiography. I. The diagnosis of vascular lesions. *J. Neurosurg.*, Jan., 1946, 3, 25-45.

With cerebral angiography the site of a suspected vascular lesion and often its anatomic character may be revealed. It is indicated in suspected vascular lesions of the brain whenever surgical treatment is under consideration and a precise diagnosis is required for such therapy. It is contraindicated in very old patients and those with far advanced arteriosclerosis, hypertension, cardiac decompensation, or recent embolic or thrombotic episodes. It is likewise contraindicated in most cases of acute intracranial hemorrhage unless conservative management carries greater risk than surgical treatment.

In carotid arteriography the carotid bifurcation is surgically exposed and under carefully controlled technique thorotrast is injected into either the beginning of the internal carotid or the common carotid artery. The injection is carefully synchronized with roentgen exposures of the head consisting of stereoscopic lateral and single anteroposterior films.

Vertebral arteriography is most easily performed by retrograde injection of the subclavian artery.

Thirty-five cases of vascular intracranial lesions have been studied by this method. These have been divided into the following groups with case histories and very good illustrations exemplifying each of the groups. Nineteen cases are briefly reviewed.

(1) *Vascular occlusion and coarctation.* Angiography is an excellent method to determine the presence and site of an arterial obstruction. Narrowing of the caliber of a vessel as well as thrombotic occlusion may be demonstrated and in chronic encephalopathies it may be possible to determine whether a lesion is inflammatory or of vascular origin.

(2) *Intracranial aneurysms.* Often the location and size of the aneurysm is clearly shown and sometimes multiple aneurysms are revealed.

However, a clot may obliterate a portion of the sac, or a sac may be too small to retain the contrast medium. The aneurysm may appear larger than the actual size if a covered perforation is present that is walled off by thickened leptomeninges. Correct diagnosis of an aneurysm of the anterior cerebral artery may be rewarded by brilliant surgical results. A differentiation between parasellar tumor and aneurysm is possible only by angiography.

(3) *Arteriovenous fistula of the internal carotid artery in the cavernous sinus.* In such cases arteriograms show direct passage of the contrast medium from the carotid into the venous system with no filling or minimal filling of the cerebral arteries. Patients with arteriovenous fistula tolerate the ligation of the carotid very well. Demonstration of the main venous return is helpful in planning the surgical treatment of pulsating exophthalmos.

(4) *Vascular malformations.* Vascular anomalies have been classified as arterial, capillary, venous and arteriovenous malformations. Except for the capillary anomalies they can be demonstrated by angiography. Of these the cirroid or racemose angioma is most common and it is of the arteriovenous type. The angiographic appearance of arteriovenous malformations may have superficial resemblance to angioblastic meningiomas or highly vascular glioblastomas, but these neoplasms always cause considerable displacement of the main cerebral vessels and their blood supply never assumes the huge and bizarre proportions found in arteriovenous malformations.—K. K. Latteier.

HAMBY, WALLACE B. Gross intracerebral hematomas; report of 16 surgically treated cases. *New York State J. M.*, April 15, 1945, 45, 866-876.

Sixteen cases of gross intracerebral hemorrhage are described. All were drained, with 14 recoveries and 2 deaths. Seven of the cases were associated with cerebral arterial disease and 5 with brain tumors, 1 was proved and 3 suspected to be due to ruptured aneurysm of the major blood vessels, and 1 case was of de-

layed post-traumatic intracerebral hemorrhage. The article is illustrated diagrammatically by superimposing diagrams of the position of the lesions and the operative approaches on air roentgenograms or roentgen plates of the skull. The 16th case—the one of post-traumatic hemorrhage in which the patient fell 18 feet—is illustrated with roentgenograms showing a shift in the position of the pineal shadow. Immediately after the accident it was in the midline; a week later it had shifted 1 cm. to the left. Immediately after drainage it was in the midline, eleven days later it was shifted to the right; 128 days later the shadow of the cavity was smaller and denser and the pineal shadow was in the midline. Examinations are to be made every six months until its position becomes stabilized.

Progress of these lesions can be checked by flushing the cavity with thorium dioxide suspension which precipitates on the walls of the cavity and makes later roentgen examination possible.—*Audrey G. Morgan.*

MATSON, DONALD D., and WOLKIN, JULIUS. Hematomas associated with penetrating wounds of the brain. *J. Neurosurg.*, Jan., 1946, 3, 46-53.

Intracranial hematomas may arise distant to the wound of entrance in the presence of a penetrating wound of the brain. If a foreign body is visualized on the roentgen examination close to the cortex of the side opposite that of entrance, its location may mark the end of the tract through the brain, but it may also have reached the meninges or skull of the opposite side and bounced back into the brain without fracturing the bone. This situation is likely to be associated with hemorrhage into the subdural or subarachnoid spaces or into the brain itself. If the hemorrhage is limited to the extradural or subdural spaces or to any one area of the cerebrum so that a localized subcortical hematoma is formed, then surgical evacuation is often possible and an early attack may be life saving.

In through and through wounds of the brain, the wound of exit always exhibits greater damage than the wound of entrance and frequently is the site of a large hematoma. It therefore should be handled first since early evacuation of a hematoma or collection of macerated brain tissue will usually result in immediate improvement of the patient's general condition.

The authors present briefly case histories

illustrating these two types of injuries.—*K. K. Latteier.*

SMOLIK, EDMUND A., BLATTNER, RUSSELL J., and HEYS, FLORENCE M. Brain abscess associated with congenital heart disease. *J.A.M.A.*, Jan. 19, 1946, 130, 145-147.

The authors report a case of brain abscess associated with congenital heart disease and outline the mode of treatment which led to complete recovery from the abscess. They state that the association of brain abscess with congenital heart disease has not been emphasized sufficiently in the medical literature. They refer to the report of Robbins, who found 3 cases of brain abscess associated with tetralogy of Fallot in a series of 58 cases of congenital heart disease discovered at autopsy. This report included 23 similar cases reviewed in the literature.

The present case report was of a nine year old white girl. At two months of age a diagnosis of congenital heart disease had been made. According to her parents, however, the patient had never suffered from "heart trouble" and was never cyanotic. Six weeks before admission she suffered a chill and felt feverish, but recovered in twenty-four hours. Two weeks later she began to have severe recurrent frontal headaches associated with vomiting. The clinical diagnosis of brain abscess was made and was verified by ventriculography. Ventricular drainage was performed for relief of pressure and later 110 cc. of thick pus was aspirated from the left frontal area. Seventeen days later the abscess capsule was drained of 180 cc. of pus and the capsule marsupialized. One year later the patient was entirely symptom free and had apparently made a complete recovery. The only confirmatory signs of congenital heart disease in this case were a prominence in the region of the pulmonary artery as seen in the roentgen examination and the electrocardiographic findings of variable T waves and rotation of the electrical axis about 180 degrees from normal.

The diagnosis of brain abscess would probably be made more frequently if brain abscess were considered more generally whenever signs and symptoms of central nervous system involvement develop in a patient with congenital heart disease. Frequent attention has been drawn to the presence of sepsis in the lesser circulation, which, by direct passage to the central nervous system, explains the development of brain abscess.—*Charles B. Coburn.*

TROLAND, CHARLES E., BAXTER, DONALD H., and SCHATZKI, RICHARD. Observations on encephalographic findings in cerebral trauma. *J. Neurosurg.*, Sept., 1946, 3, 390-398.

The authors reviewed encephalographic findings in a series of 261 patients, 206 of whom had had cranial trauma. Abnormal encephalograms were found in 74 per cent of the cases of head trauma. Unilateral dilatation of the ventricles was found in 29 per cent; symmetrical bilateral dilatation of the ventricles was found in 16 per cent of these cases, and asymmetrical bilateral dilatation in 29 per cent.

The mechanism of such dilatation is debatable, but in the majority of cases of symmetrical enlargement of the lateral ventricles and the third ventricle it is due to generalized loss of cerebral substance with secondary dilatation of the cerebrospinal system. Secondary fibrosis interfering with absorption of the fluid must also be considered. When, however, the third ventricle is not enlarged the dilatation is most likely due to diffuse cerebral atrophy secondary to trauma. In bilateral asymmetrical enlargement of the lateral ventricles the side of the greatest enlargement of the lateral ventricle was always on the side of the injury in both open and closed head injuries. With unilateral enlargement of the lateral ventricles there was direct loss of cerebral substance without diffuse cerebral change.

In checking the appearance of the ventricles on the day following the encephalography, enlargement was often more marked, parenchymal cysts often became visible on the later films, and at times a peculiar bulging of the interventricular septum was found. These studies indicated that existing brain atrophy was at times much more obvious on the second day and that the differential diagnosis between a space-occupying process and atrophy was facilitated in some cases by the follow-up study.—K. K. Latteier.

THOMPSON, RAYMOND K. Cystic cerebellar arachnoiditis. *J. Neurosurg.*, Nov., 1946, 3, 461-468.

Cystic cerebellar arachnoiditis is a pathological state of scarring of the leptomeninges in the posterior cranial fossa, resulting in an internal hydrocephalus and a cystic accumulation of fluid at the site of the cisterna magna. It is most probably the result of a bloody, bacterial or contiguous inflammatory reaction in the subarachnoid space.

This cyst acts as a space-consuming mass in the posterior fossa, elevating the cerebellar hemispheres and pushing the cerebellar tonsils into the foramen magnum, and thereby partially obstructing the flow of the cerebrospinal fluid.

Such a cyst may be the result of a mild trauma and manifest itself by signs secondary to blockage of the flow of cerebrospinal fluid or by local pressure effects. The former produces headache, papilledema, bradycardia, abducens paralysis, episodes of syncope, transient episodes of blindness, etc., while the latter produces nystagmus, ataxia, partial or complete paralysis of the 5th, 7th or 8th cranial nerves, etc. These cannot be clinically differentiated from the picture produced by a primary neoplasm unless the relationship to trauma or infection arouses suspicion. Skull roentgenograms and spinal fluid studies are of no value in the differential diagnosis.

The author describes in detail an illustrative case of the disorder. The roentgen studies in this case were negative except for symmetrical dilatation of the lateral, 3rd and 4th ventricles with rostral angulation of the aqueduct and 4th ventricle. At operation a cyst was found occupying the lower right half of the posterior fossa and bulging into the foramen magnum. There was elevation of the right cerebellar hemisphere and flattening of the cerebellar tonsils which were pushed anteriorly and down into the foramen magnum against the medulla.

The course of the patient's symptoms are very well correlated by the author with the neurologic and operative findings. He also points out the possible relationship of this condition to post-traumatic suboccipital neuralgia.—K. K. Latteier.

POSNER, MARVIN, and HORRAX, GILBERT. Eye signs in pineal tumors. *J. Neurosurg.*, Jan., 1946, 3, 15-24.

Material for this study consisted of 16 cases in which a diagnosis of pineal tumor was made at the Lahey Clinic. In 11 of the 16 patients the lesion was verified histologically. In the other 5 patients the clinical picture, the ventriculogram, and the course following decompression and radiation therapy made the diagnosis sufficiently certain to include them in this survey.

General features shown by these patients included: (1) increased intracranial pressure; (2) eye signs, such as impaired pupillary reac-

tions, limited extraocular motion, nystagmus and strabismus; (3) central deafness; (4) cerebellar signs. In addition, other general disturbances of function were present including endocrine dysfunction, diabetes insipidus, and dystrophia adiposogenitalis.

The eye signs in 16 cases of pineal tumors are tabulated and the following data may be summarized: (1) Dilated pupils were present in 31 per cent of cases and in 50 per cent there was impaired reaction to light. Reaction of the pupils on accommodation was impaired in only 12 per cent of the cases. (2) Papilledema was present in 56 per cent of the cases, with an average of 4 diopters elevation. (3) Upward gaze was limited in 31 per cent of the cases.

Observation of the fundi, the extraocular movements and the pupillary reactions may help formulate the diagnosis of a pineal tumor when seen in conjunction with ventriculograms showing the characteristic defect in the posterior part of the third ventricle.

An accurate diagnosis may save the patient the risk of a craniotomy on the basis of a mistaken diagnosis of cerebellar neoplasm.

The patient with a pineal tumor can usually be offered a better prognosis by subtemporal decompression and radiation therapy.—*K. K. Latteier.*

DAVIDOFF, LEO. M. Coarctation of the walls of the lateral angles of the lateral cerebral ventricles. *J. Neurosurg.*, May, 1946, 3, 250-256.

In cooperation with the Radiographic and Pathological Departments of the Jewish Hospital of Brooklyn, the author examined 64 brains taken routinely from cases without brain tumor or any other known neurological disease. In 4 cases he found an asymmetry of the lateral ventricles on both postmortem pneumoventriculograms and in the brain specimens on coronal sections. In addition, 6 cases of asymmetry of the ventricles were observed only on the roentgenograms and 10 cases in which deviations of a similar nature were seen only on coronal sections of the brain.

In anteroposterior encephalograms the asymmetry consists of a normal looking "butterfly wing" pattern of the ventricle on one side and a truncated one on the other side. In brain specimens showing asymmetrical developments of the two lateral ventricles, closely resembling the encephalograms, there appeared to be a coarctation of the adjacent walls of the lateral ventricles on the side of the smaller ventricle.

In some specimens the adhesions were incomplete so that beyond the truncated end of the ventricle and the site of adhesion was a small cavity. Microscopic examination showed no degenerative changes or cellular proliferation. No evidence of inflammatory reaction, gliosis, or fibrosis was found in any of the sections examined.

It is the author's opinion that the coarctation of the cerebral ventricular walls occurs during the developmental period of the brain and that it can be classed as a congenital deformity.—*K. K. Latteier.*

#### NECK AND CHEST

STUART, F. G. Pathological manifestations and anatomical variations in pre-enlistment chest roentgenograms. *Canad. M. Ass. J.*, May, 1945, 52, 477-481.

The author summarized his findings in a series of 19,050 pre-enlistment roentgenograms of the chest. He found that healed primary tuberculosis occurred with equal frequency throughout all parts of both lungs. Reinfection tuberculosis was found to be predominantly apical.

The parenchymal components of primary tuberculosis showed a 30 per cent greater tendency to undergo complete roentgenographic resolution than did the hilar components.

Obliteration of the costophrenic sulcus was considered as being most often of primary tuberculous origin.

At least 0.2 per cent of the adult population examined revealed roentgen evidence of lung disease of which they had not been previously aware.

When the cardiothoracic ratio was 50 per cent or over, there was an even chance that cardiac disability would be found.

The importance of demonstrating apical lesions by resorting to special lordotic projections or films made with the two angled tube is excellently demonstrated.—*Philip J. Hodes.*

ROCHAT, PAUL. 5000 radiophotographies à Lausanne: 1943 à 1945. (Five thousand photoroentgenograms at Lausanne: 1943-1945.) *Radiol. clin.*, Jan., 1946, 15, 49-53.

The author, who is school physician of Lausanne, discusses 5,000 photoroentgenograms of 90 per cent of the students and 30 per cent of the teaching force of that city. A decision as to whether the subjects have tuberculosis can only be made if the photoroentgenography is sup-



plemented by roentgenoscopy and roentgenography. In many cases the Pirquet reaction and red cell sedimentation rate were also obtained.

In 21 cases, there were marked sequels of tuberculosis, such as pleural adhesions, calcifications, etc. There were 17 cases with suspicious shadows and 9 with definite pathology. Three of these cases with pulmonary infiltration, resembling the initial foci of Malmros and Hedval are described in more detail. These initial foci generally show a progressive course with softening and ulceration. These cases require long and careful supervision. Photoroentgenograms of the 3 cases are given.—*Audrey G. Morgan.*

HUMBERT, R. Les examens radiophotographiques dans le canton de Neuchâtel. (Photoroentgenographic examinations in the canton of Neuchâtel.) *Radiol. clin.*, Jan., 1946, 15, 37-49.

The early detection of tuberculosis has become particularly important with the increase of the disease from the malnutrition and poor hygienic conditions brought about by the war. But important as diagnosis is it must be supplemented by increased facilities for hospitalization, helping the patients to readapt to social life when they are discharged and giving their families material support while they are in hospital.

The author discusses the advantages of photoroentgenography as compared with simple roentgenoscopy, though both methods have their indications. The films should be interpreted by a committee made up of a specialist in tuberculosis, one in internal medicine, one in roentgenology and a general practitioner. As soon as possible after they are examined the subjects are notified of the results of the examination. To Class A, in whom no roentgen signs of tuberculosis have been detected the notice states that there are *at present* no signs of disease, bearing in mind that such signs may appear quite soon after a negative roentgen examination. Those in Class B are notified that the findings indicate that they should have a complete medical examination and those in Class C that medical examination and treatment are urgent.

Surprisingly enough, a higher percentage of involvement was found in adults than in students. Among 10,805 students there were pathological findings in 0.9 per cent, among 14,173

adults in 1.66 per cent and among 4,078 military recruits in 0.5 per cent.

He discusses the question of whether examination should be made compulsory or remain voluntary and decides in favor of voluntary examination but with increasing educational effort so that increasing numbers of the population will come for voluntary examination.

A resolution adopted by the Roentgen Society declared in favor of compulsory examination with the appointment of a committee to coordinate the work in photoroentgenography, in collaboration with social and medical organizations interested in the question.—*Audrey G. Morgan.*

SCHINZ, H. R. Die Schirmbildphotographie. (Photoroentgenography.) *Radiol. clin.*, Jan., 1946, 15, 36.

The importance of roentgen examination of the Swiss people in the detection and treatment of tuberculosis has only recently been recognized. In the course of the past year 16,000 roentgen examinations have been made at the Roentgenological Institute in Zürich. It is important to collect accurate statistics and to differentiate between the number of findings and the number of persons examined for often there are several different findings for a single individual.

As was to be expected the pathological findings among the civil population were much greater than in the army, 16.5 per cent as compared with 7.5 per cent. Among 100 pathological findings in the civil population, 30 were very important, 26 relatively important and 44 unimportant, while the corresponding figures for the army were 17, 24 and 59. Among 5,300 pathological findings there were 7 cases of tuberculosis that had not been diagnosed before, that is 0.13 per cent. Calculating this percentage for the 3,000,000 of Switzerland would give 4,000 new cases of open tuberculosis. This figure alone shows the necessity for roentgen examination on the whole population. This would show the infectious cases and they should be reported to the Tuberculosis League; it is of no use to detect the infectious cases unless they are given treatment to render them non-infectious. (Author's abstract. Complete article appears in *Schweiz. med. Wchnschr.*—*Audrey G. Morgan.*

MYERS, J. A. The establishment and use of fundamental procedures in tuberculosis con-

trol. *Pub. Health Rep.*, Nov. 1, 1946, 61, 1563-1583.

This is a report of the tuberculosis control work in Minneapolis, Minn., for the past twenty-five years. Its effectiveness is proved by the fact that the tuberculosis mortality has been reduced from 120 per 100,000 in 1920 to 27.1 in 1945. Every promising method of control has been tried and many early erroneous impressions have been corrected. For instance, it has been found that primary tuberculosis does not require treatment; children with primary tuberculosis did as well without as with treatment.

But reinfection is an entirely different matter. The tuberculin test alone only proves the presence of infection. It gives no information as to whether the case is one of primary infection or reinfection. Neither is roentgen examination pathognomonic. Lung calcification may be caused by other conditions than tuberculosis. But no case of proved tuberculosis has been found among individuals who did not react to tuberculin. Therefore all persons who react positively to tuberculin should be given roentgen examinations every six to twelve months. Roentgen shadows appear before clinical signs of disease, so this examination is important. Cases that have not yet become infectious can be treated successfully with ambulatory artificial pneumothorax. All patients who have become infectious should be hospitalized. The objection that there are not enough beds is not a valid one. The public should see that there are enough beds.—*Audrey G. Morgan.*

Biggs, A. D. A roentgen ray and clinical study of primary tuberculosis. *Arch. Int. Med.*, April, 1946, 77, 393-404.

In this study 460 children were studied and tested by the intradermal injection of a purified protein derivative and the Vollmer patch test. Of the total, exactly one-fourth, or 115, reacted to at least one of the tests. Since all tuberculin tests are based on an allergic phenomenon, it follows necessarily that none is infallible. The possibility of false negative reactions and false positive reactions must always be borne in mind. For this reason, it was considered necessary to keep each positive reactor under close clinical observation and to study him with serial roentgenograms.

As to the nature of primary tuberculosis of the lungs, it is believed by the author to be a

subclinical disease. It cannot be detected by making a physical examination or by making a blood count or by keeping a record of the child's weight and growth. History of exposure is the only satisfactory criterion by which it may be suspected. A tuberculin test is the only efficient means of detecting it. Serial roentgenograms are the most satisfactory means of following its course.—*James J. McCort.*

HIATT, JOSEPH S., JR., and MARTIN, DONALD S. Recovery from pulmonary moniliasis following serum therapy. *J.A.M.A.*, Jan. 26, 1946, 130, 205-206.

This case of severe pulmonary moniliasis is presented because of the unusual immunologic findings and because of the dramatic recovery which followed the administration of immune serum.

A white woman, aged forty-four, married, a housewife, was admitted with the chief complaints of malaise, fatigue, cough and loss of weight for the preceding two months. Following onset of her symptoms she had a cough, productive of 1 tablespoon of mucoid, odorless sputum daily. She noted afternoon temperature elevation as high as 39.4° C. (103° F.) but no frank chills, chest pain, hemoptyses or night sweats. Iodides were administered by her physician but had to be discontinued because of the appearance of a pustular eruption on the face. Three weeks prior to admission she received, over a ten day period, a course of one of the sulfonamides with some subjective improvement. *Candida albicans* was isolated from the sputum on numerous occasions. Fluoroscopic and roentgenographic examinations of the chest showed diffuse densities throughout both lung fields, most likely due to infiltration, with lesions at the left base somewhat coalesced. The roentgen findings were interpreted as being consistent with a diagnosis of a diffuse bronchomycotic infection. The patient was skin tested with an autogenous vaccine of *Candida albicans* isolated from her sputum, and the reaction was negative. No agglutinins for the fungus could be found in the patient's serum. Because of a previous experience with a patient suffering from North American blastomycosis who had the same immunologic findings, i.e. negative skin test to *Blastomyces* vaccine, a negative complement fixation test and a positive immediate reaction to an anti-*Blastomyces* rabbit serum, it was decided to test this patient

with serum of a rabbit which had been previously immunized with *Candida albicans*. Injection of 0.1 cc. of the anti-*Canadida albicans* rabbit serum resulted in the formation of a wheal pseudopodia surrounded by a 5 cm. zone of erythema. Hypersensitivity to rabbit serum was excluded by injection of 0.1 cc. of normal rabbit serum, to which there was no reaction. The immunologic findings were interpreted as indicating that the patient was flooded with an excess of the fungus antigen, which inhibited both the agglutination reaction and the skin test to the vaccine. The patient was given immune anti-*Candida albicans* rabbit serum subcutaneously, beginning with 0.1 cc. of a 1:10 dilution, and the dose was increased by 0.1 cc. daily until a dose of 0.9 cc. was reached. The desensitization series was repeated twice. Following serum therapy there was a total remission of all subjective symptoms. Follow-up roentgenograms of the chest were interpreted as essentially normal. The skin test to *Candida albicans* has remained negative but the agglutinins were still positive in a 1:80 dilution.—*Samuel G. Henderson.*

HIGH, ROBERT H., and ZWERLING, HENRY B. Variation with age in the frequency of tuberculous pulmonary calcification. *Pub. Health Rep.*, Dec. 6, 1946, 61, 1769-1782.

Calcification in the lung parenchyma or tracheobronchial lymph nodes frequently follows tuberculous infection in children but is much rarer in adults. In adults healing is generally by fibrosis.

The authors therefore made a study of the variations in frequency of calcification in a group of 1,457 American Indian children who had been used as controls in testing the effectiveness of BCG vaccine. During the period of observation 198 cases of tuberculosis occurred and calcification later developed in 49 of these. It was found that children who develop a tuberculous lesion before the age of five years have 7 chances in 8 of developing calcification, between five and nine, 5 chances in 8, ten to fourteen, 3 chances in 8 and fifteen to nineteen 1 chance in 8. The percentage of calcifications varies not only with age but with the type of tuberculosis. There is no significant difference in the sexes. Calcification is more frequent on the right side than on the left, 71.4 per cent on the right and 36.7 per cent on the left. This closely follows the distribution of the local lesions which were on the right in 61.6 per cent

of the cases and on the left in 46 per cent.

In addition to these 198 cases of tuberculosis 402 children became sensitive to tuberculin during the period of observation. No evidence of tuberculosis was seen in this group though roentgenograms were made frequently. Only 2.2 per cent of these children developed calcification as compared with 24.7 per cent in the group with tuberculosis. From this it would appear that most tuberculous calcifications are preceded by lesions that can be demonstrated by roentgen examinations.

Tables and charts showing the details of the findings are given.—*Audrey G. Morgan.*

CASTELLANOS, AUGUSTIN, and GALAN, ENRIQUE. Sarcoidosis (Besnier-Boeck-Schaumann's disease). *Am. J. Dis. Child.*, May, 1946, 71, 513-529.

This paper is a case report of sarcoidosis occurring in a six year old white Cuban boy. The disease started when the child was three years old with a gradual onset, prolonged fever and chronic polyarthritis deformans, with splenomegaly simulating Still's disease. The clinical picture was characterized by a miliary-like mottling of both lungs as shown in the roentgenograms of the chest, enlarged mediastinal and peripheral lymph nodes, a symmetrical erythematous macular cutaneous eruption on the cheeks, nose, shoulders and arms with brownish pigmentation and small telangiectases and atrophy of the epidermis. Ocular manifestations were observed such as moderate exophthalmos, recurrent internal strabismus, congestion of the conjunctivas, a pinpoint non-vesicular keratitis, involvement of the uveal tract and synechia of both irises.

Typical granulomas with or without multinucleated giant cells, but formed by epithelioid cells like those reported in sarcoidosis, were found in the subcutaneous tissue and peripheral muscle (deltoid). A diffuse infiltration of epithelioid cells was observed in the lymph node, which was excised, which had the characteristics of a reticuloendotheliosis. Diagnostic puncture of the lung and aspiration of the sternal marrow yielded numerous histiocytes and multinucleated cells respectively, those found in the bone marrow being similar to the giant cells seen in sarcoid granuloma.

The involvement of the large joints in the form of a chronic polyarthritis deformans was an unusual feature of the case and no similar instance could be found in the literature. No

roentgenographic examinations of the joints were made.

The condition was complicated by tuberculosis as indicated by a late strongly positive tuberculin reaction, a fibrinous pleurisy and a pneumonic process in the lower right lung, regarded by the authors as due to tuberculous lobular involvement. A footnote of the case history states that after this paper was submitted for publication the patient developed a Pott's abscess of the dorsal spine and died later from tuberculous meningitis, secondary to the abscess.—*R. S. Bromer.*

HIGH, ROBERT H. Calcifications in the spleen; occurrence in histoplasmin and tuberculin reactors. *Pub. Health Rep.*, Dec. 6, 1946, 61, 1782-1786.

Calcifications of the spleen may be produced by various causes but it has been believed generally that tuberculosis is the most frequent cause.

In 1945 the Tuberculosis Control Division of the United States Public Health Service, in cooperation with the Board of Education, the City Health Department and the Tuberculosis Society of Kansas City, Missouri, made histoplasmin and tuberculin tests and chest roentgenograms of over 17,000 patients.

In 15 children and 5 adults the original chest films were definite enough to justify a diagnosis of splenic calcifications. There were 33 more suspicious cases. Among the 19 of these 20 patients given the skin tests 9 (47.4 per cent) reacted to tuberculin, while 16 (84.2 per cent) reacted to histoplasmin. Therefore apparently tuberculosis is not the only or even the most frequent cause of calcifications of the spleen in Kansas City, Mo. It is probable that many more cases of splenic calcification would have been found if routine examination of the splenic area with the Potter-Bucky diaphragm had been made.

The percentage of histoplasmin reactors among those with splenic calcifications is almost twice as high as among the general population and about the same as the percentage of histoplasmin reactors among those with lung calcification. This suggests that the agent that causes pulmonary calcifications also causes splenic calcifications, also that the causative agent is blood borne. Three cases were seen in which there were also liver calcifications and these also were probably blood borne.—*Audrey G. Morgan.*

VAN ORDSTRAND, H. S., HUGHES, ROBERT, DE NARDI, J. M., and CARMODY, MORRIS G. Beryllium poisoning. *J.A.M.A.*, Dec. 15, 1945, 129, 1084-1090.

The authors present an analysis of 170 cases of poisoning attributed to the industrial exposure of workers to beryllium compounds, stressing the increasing importance of this substance in industry. During a four year period 170 cases of poisoning were seen by them in three industrial plants using beryllium, its compounds and alloys.

Manifestations of poisoning included contact dermatitis, chronic skin ulcer and inflammatory changes in the respiratory tract. The specific etiology is not known, manifestations apparently being caused by several beryllium compounds,—in this study the sulfating and oxy-fluoride processing showing the highest incidence. Clinical manifestations occurred only after exposure and cleared completely when proper precautions were observed or when work was terminated.

Severe manifestations in furnace tenders were those of nasopharyngitis and tracheobronchitis. Tracheobronchitis was characterized by cough, rales in both lungs and normal serial roentgenograms. There was an occasional low-grade fever but the temperature was never elevated over one degree.

Clinical pneumonitis developed in 38 workers and was the severest manifestation of the disease and progressed either to complete recovery or to death. The 5 deaths reported in this series were all attributed to pneumonitis. Clinically the pulmonary changes were characterized by: (1) cough, with occasional blood-streaked sputum; (2) substernal burning pain; (3) shortness of breath; (4) cyanosis in most cases; (5) an abnormal taste; (6) anorexia with weight loss; (7) fatigue.

Physical findings in cases of pneumonitis were: (1) rapid pulse; (2) rales over both lungs; (3) reduced vital capacity. Signs of infection were conspicuously absent. Roentgenologic changes in the lungs did not usually appear for two to three weeks after the onset of symptoms and physical signs. These changes were bilateral and diffuse in all cases. In order of appearance the changes were: (1) diffuse haziness of both lungs; (2) soft irregular areas of infiltration with prominence of peribronchial markings; (3) absorption of soft infiltration and appearance of discrete large or small conglomerate

nodules scattered throughout both lung fields; (4) clearing of the lungs after one to four months.

Pathologically, affected areas of lung tissue showed large numbers of plasma cells, diffuse edema, hemorrhagic extravasation and relative absence of polymorphonuclear infiltration.—*Charles B. Cobern.*

SPAIN, DAVID M., and HANDIER, BERNARD J. Chronic cor pulmonale. *Arch. Int. Med.*, Jan., 1946, 77 37-65.

A necropsy study of 60 consecutive cases of cor pulmonale unassociated with other forms of heart disease is the basis for this paper.

The underlying pulmonary conditions in these cases were as follows: emphysema 40; bronchiectasis 6; bronchial asthma 6; silico-tuberculosis 3; pulmonary tuberculosis 2; kyphoscoliosis 1; pulmonary arteriosclerosis 1; organized pulmonary thrombi 1. Thus diffuse obstructive emphysema, either primary or secondary to such diseases as pulmonary tuberculosis or silicosis, was considered to be the significant underlying pulmonary factor in the vast majority of the cases.

Diffuse obstructive emphysema was thought to produce a changed pressure relation within the alveoli and in this manner result in an increased resistance to the flow of blood in the lungs. This change was considered to be a primary mechanism in the development of cor pulmonale while such associated factors as anatomic obliteration of the pulmonary vascular bed, fibrosis of the lung, compensatory polycythemia and overfilling of the heart were considered to be aggravating factors of varying significance.

Roentgenographic studies of the chest revealed the changes described above in the pulmonary parenchyma. Great variations were seen in the size of the heart. In a relatively small number the cardiac shadow showed definite evidence of enlargement and alterations in the cardiac borders consistent with an enlarged right ventricle. In these cases the left cardiac border showed either straightening or prominent convexity in the area of the pulmonary artery in the posteroanterior view and fluoroscopic examinations revealed the associated displacement of the point of opposite impulse in an apical direction. These classic roentgenographic findings in cor pulmonale were seen in those cases in which the underlying pulmonary

change was at a minimum as compared with the interference with the pulmonary circulation, that is, in the case of primary pulmonary arteriosclerosis and in the cases of pulmonary fibrosis with relatively little pulmonary emphysema.

However, in the great majority of cases in this series, the classic roentgenographic picture of cor pulmonale was masked or hidden by the alterations in the chest created by extensive emphysema, fibrosis, pleural obliteration or kyphoscoliosis. In the cases of emphysema the depression of the diaphragm resulted in an elongation of the mediastinum, so that the heart appeared smaller than normal. The increase in lateral diameter of the chest resulting from the elevation of the thoracic cage associated with emphysema made the determination of the cardiothoracic ratio spurious. In a large number of cases of this kind, even minor changes in the cardiac silhouette seen on fluoroscopic examination were of significance. Prominence of the area of the pulmonary artery or of the outflow portion of the right ventricle in the right and oblique position or displacement toward the apex of the point of opposite pulsation were the only changes indicative of enlargement of the right ventricle.—*James J. McCort.*

HARVEY, ELINOR B., and HOGG, PAUL. Thrombosis of the pulmonary artery in children. *Am. J. Dis. Child.*, Jan., 1946, 71, 67-76.

The authors report a case of thrombosis of the pulmonary artery in a boy, seven years old. Fourteen previously reported cases were found in the literature. The patient's symptoms were of seven months' duration, following an automobile accident causing a contusion of the right side of the chest. The presenting signs and symptoms were cyanosis, dyspnea, fever, cough, hemoptysis and abdominal pain. The roentgen examination of the chest showed an extensive amount of infiltration, spotty in type, extending from the level of the first rib to the diaphragm in the inner zone of the right lung. In the left lung there was a mild amount of infiltration spreading from the left hilum. The picture simulated a pneumonic process of the right lung with failure of the right side of the heart. Severe secondary anemia persisted in spite of therapy. Tuberculosis was ruled out. The condition showed no improvement at any time. Death occurred after two convulsions, probably of anoxic origin.

On post-mortem examination, an opening was found in the interventricular wall. The pulmonary artery was filled with a laminated thrombus which filled the spaces back of the pulmonic valve flaps and extended slightly into the right ventricle. The thrombus involved the right branch, so that it extended into the pulmonary tissue, practically occluding the vessels which enter the lower lobe, with extension into one branch in the lower portion of the upper lobe. There was massive pulmonary infarction, abscesses of the lower lobe of the right lung, extreme edema of the lungs and acute fibrinous pleurisy.

The origin of thrombosis of the pulmonary artery may be: (1) primary in the vessels or, more commonly, (2) secondary to a disease process outside the pulmonary vessels. The case reported falls into the second category.—*R. S. Bromer.*

GREGG, GRACE S., and GREGG, FRANK J. Severe rheumatic heart disease in children. *Pennsylvania M. J.*, Dec., 1945, 44, 247-249.

A study of 101 cases of acute rheumatic heart disease in children is presented. The average age was 8.5 years. The cases were observed in an eighteen month period. Of these, 60 patients were seen in the first attack while the remaining 41 included many followed during previous admissions or treated elsewhere. Death occurred in 20 cases, 11 during the first attack, 4 during the second and 5 in the fourth attack.

Certain signs were present with much greater frequency in the fatal cases than in those who recovered. Congestive heart failure was noted from the onset in all of the fatal cases reported. These signs were present for varying periods in 15 patients who ultimately recovered. Congestive heart failure is regarded as an ominous sign when it is a part of the clinical picture of rheumatic activity.

A sustained gallop rhythm with the third sound occurring early in diastole was the most unfavorable auscultatory sign in the cases studied. In the fatal cases it was heard in 18 instances. It was also present in 14 patients who recovered. Gallop rhythm is an ominous sign and is regarded as an evidence of rheumatic activity even at times in the presence of a normal sedimentation rate.

Pericardial friction rub was heard in 14 of the 20 fatal cases. In 2 instances there was electrocardiographic evidence of pericarditis

without an audible rub. On the other hand, this sign was demonstrated in 9 patients who ultimately recovered. In summary, congestive heart failure, gallop rhythm, and pericardial friction rub, especially when noted together constitute an important triad.

A roentgenogram of the chest was made for heart size and shape when the condition of the patient permitted. Cardiac enlargement of a rather marked degree was seen in all of the fatal cases in which this procedure was carried out. It is well to note the extreme difficulty, if not the impossibility, of differentiating acute cardiac dilatation from acute pericarditis with effusion by roentgenography. The cardiac pulsations ordinarily seen by fluoroscopy or kymography are decreased and may be absent in either of these conditions. This point is regarded as of extreme practical importance in the treatment of these cases. At times the paracentesis of even small amounts of pericardial fluid will result in striking clinical improvement. It is contended that a very careful exploration of the pericardium with procaine anesthesia is a safe and justifiable procedure.

The electrocardiogram proved of little value in detecting significant myocardial changes. The erythrocyte sedimentation test was found to be a reliable procedure to detect the presence of rheumatic activity, although of little quantitative value. The white blood count, pulse and temperature were not reliable indices of the severity of the illness.—*Charles B. Cobern.*

GARLAND, LEO H. Myocardial infarction—roentgen diagnosis. *U. S. Naval Med. Bull.*, 1944, 45, 89-96.

Roentgen kymography is a method of recording the movements of an organ on a roentgen film. In multiple slit kymography, which is the form generally used, only the movements parallel to the slits are recorded but by turning the slits at various angles the motions of different parts of the organ may be recorded. This method is particularly valuable in cases of myocardial infarction in which the clinical and electrocardiographic findings are negative or indefinite. This occurs in about 15 per cent of the cases, particularly in the early stages. A negative kymographic finding does not necessarily prove there is no infarction but negative findings with infarction occur in less than 30 per cent of cases. The intensity of the positive

findings increases with increase in the extent and severity of the infarction. The positive kymographic findings are localized decrease or absence of pulsation, systolic expansion or paradoxical pulsation and partial systolic expansion or marked diastolic irregularities.

A case is described in a naval officer forty-eight years of age who was admitted with a diagnosis of angina pectoris. The clinical findings were slight and the electrocardiogram within normal limits. The roentgen kymogram showed waves of poor amplitude over part of the left ventricular margin near the apex with paradoxical motion in frames 3 to 5 above the left diaphragm. A diagnosis of infarction was made. After ten days' rest in bed the patient was discharged. That night he had an attack of severe chest pain, went into shock and died. Autopsy confirmed the diagnosis showing an extensive fresh infarction of the lower part of the interventricular septum and a portion of the anterior wall of the left ventricle; also patchy coronary sclerosis and generalized arteriosclerosis.

Two roentgen kymograms of the case are given.—*Audrey G. Morgan.*

ROBLEE, MELVIN A., and MOORE, SHERWOOD. "Lipiodol" pulmonary emboli following hysterosalpingography. *South. M. J.*, Feb., 1945, 38, 89-94.

The patient reported had been previously operated upon when sterilization was accomplished by partial tubal resection following a classical cesarean section. Because of the death of her only child, the patient desired operative correction of her sterility. In the course of her study, a hysterosalpingography was performed approximately ten days after her last menstrual period.

Approximately 9 cc. of lipiodol was injected into the uterus at which time the patient began to complain of pain. The intra-uterine pressure was maintained at approximately 140 to 150 mm. of mercury. At the time of the exposure, the patient began to breathe rapidly and an increase in the pulse rate was noted but there was no swelling or other signs of shock. It was not until the roentgenogram was examined that diffusion of the lipiodol into the vascular system was suspected. It was estimated that approximately 5 cc. of iodized oil entered a uterine or tubal vein, probably through the operative defect of the uterus.

The first film of the pelvis revealed lipiodol

in all the uterine veins. Approximately fifteen minutes later, a second roentgenogram of the pelvic region revealed only a slight amount of lipiodol either in the large internal iliac veins or lymphatics.

A film of the chest made approximately fifteen minutes after the injection of the uterus revealed a brilliant pattern of the entire bronchovascular tree out to and including the alveoli. Some of the contrast oil was observed in the connective tissues of the arms and chest wall as well.

The patient was hospitalized but except for the presence of some rales in both lower lobes, no abnormalities were noted in the chest. Whereas the patient's urine before injection was essentially negative, the urine after the lipiodol injection revealed a 4 plus albumin. The urine looked red but no red blood cells were noted within it.

A survey abdominal film made twenty-four hours after the accident revealed no lipiodol in the region of the uterus or upper abdomen. Iodized oil was still evident in the chest, however, although it had decreased considerably in quantity. Films of the skull and careful studies of the patient's eye grounds revealed no lipiodol emboli.

A film of the chest obtained twelve days after the accident revealed no residual abnormalities in the lungs.

In reviewing the literature, the author called attention to the fact that many similar cases were reported without untoward results. He called attention to the fact that lipiodol had been injected into humans deliberately without striking sequelae.

In contrast to the normal benign course of lipiodol embolism, the author calls attention to the fatalities that have occurred in many patients following air embolism. He concludes that lipiodol is a much safer medium for hysterosalpingography than air.

The article is excellently illustrated.—*Philip J. Hodes.*

MAHON, GEORGE S. Reaction following bronchography with iodized oil. *J.A.M.A.*, Jan. 26, 1946, 130, 194-197.

The author presents a case of fatal reaction following bronchography with iodized oil and describes the clinical and pathological changes observed.

Severe or fatal reactions are relatively rare following instillation of iodized oil into the



tracheobronchial tree. White and Bayliss in 1943 could find in the literature to that date only 8 cases of severe reaction, 3 of them fatal. Crip and Hampsey learned of no deaths as a result of questionnaires circulated to 64 physicians doing bronchographic studies on 1,205 asthmatic patients. Although about 300 bronchograms are performed yearly at Mayo Clinic, according to Good "there has never been a fatal accident following bronchography in the memory of any one, including myself, who has worked in this field at this clinic."

The case reported was that of a white man, aged forty-one, admitted to the hospital because of gastroenteritis. The signs and symptoms cleared in twenty-four hours, but a chest roentgenogram showed findings suggestive of bronchiectasis, and bronchographic studies were undertaken. Before bronchography the patient was given  $1\frac{1}{2}$  grains of seconal and the larynx was anesthetized with 3.5 to 4 cc. of cocaine. A rubber tube was inserted and 10 cc. of lipiodol was injected into the base of each lung. The roentgen examination was completed and the patient stated he felt well. Shortly afterwards he complained of vague difficulty in breathing. Twenty minutes later he had a severe generalized convulsion, became cyanotic and stopped breathing.

Autopsy showed collapse of both lungs, the cut surfaces of which had the appearance of atelectasis. The tracheobronchial tree was completely filled with thick tenacious mucus which plugged even the smallest bronchioles. Microscopically the bronchi and largest bronchioles had thickened infolded mucosa and the lumens were stenosed and filled with mucus. The basement membrane was thickened and hyalinized. The smaller and terminal bronchioles were dilated and their walls and the peribronchiolar tissues were heavily infiltrated by eosinophils, neutrophils and lymphocytes. The tissue eosinophilia in these areas was striking and seemed to be directly proportional to the severity of the dilatation of the lumens.

The possibility of cocaine poisoning was ruled out by the time interval and the pathologic changes. It was held obvious that the immediate cause of death was asphyxia due to the plugging of the bronchial tree by thick, viscid mucus. The asphyxial nature of death was confirmed by the terminal hyperglycemia of the arterial circulation, a finding noted as a characteristic postmortem finding in deaths due to asphyxia.—*Samuel G. Henderson.*

FINLAND, MAXWELL, DAVIDSON, CHARLES S., and LEVENSON, STANLEY M. Effects of plasma and fluid on pulmonary complications in burned patients; study of effects in victims of Cocoanut Grove fire. *Arch. Int. Med.*, May, 1946, 77, 477-490.

The exact cause of the pulmonary lesions in the victims of the Cocoanut Grove fire was not determined. It seemed reasonable to assume that the injuries were the result of prolonged exposure to the ordinary gases and fumes which result from the incomplete combustion of the type of furnishings which were to be found in the Cocoanut Grove building. The severity of the injuries seemed to be related to the amount of actual exposure to these fumes and to the flames before the victims got out into the open air. The symptoms and roentgenologic and pathologic findings were consistent with a severe laryngotracheobronchitis which, because of the edematous and membranous character of the inflammatory reaction in the tracheobronchial tree, gave rise to obstruction of the air passages, which in turn resulted in scattered areas of atelectasis and emphysema.

It is possible, therefore, that the nature of the lesions in these cases could account for the failure of the large amounts of plasma and other fluid to aggravate the pulmonary symptoms. Indeed this form of therapy may have had a salutary affect on the pulmonary lesion similar to that which it may have on surface burns. Pulmonary edema did not occur and respiratory complications, in general, were not aggravated as a result of this therapy.—*James J. McCort.*

OLENIK, JACOB L., and TANDATNICK, JOSEPH W. Congenital mediastinal cysts of foregut origin. *Am. J. Dis. Child.*, May, 1946, 71, 466-476.

A case is reported in this paper of gastroenteric cyst of the mediastinum in a newborn infant. The patient was a nine day old white male infant admitted to the pediatric service because of several attacks of dyspnea, rapid breathing and cyanosis occurring sporadically during the previous two days. The roentgenogram of the chest showed pronounced atelectasis of the lungs with obstructive emphysema at the bases. The cyst, found later at autopsy, was not visualized. Several hemivertebrae were noted in the mid-dorsal area.

The literature was reviewed and 74 cases, including the 1 reported in this paper, were



found. In 35 the cysts were lined with respiratory epithelium; in 12 with primitive esophageal epithelium; in 15 with gastric mucosa; in 4 with intestinal mucosa and in 8 with mixed types of esophageal, gastric, enteric, and respiratory epithelium. In the case reported, the cyst wall in one section resembled the intestinal wall and in another, stomach wall. The authors believe all these cysts have a common origin in the primitive foregut. The classification of the cysts depends on the histologic structure of their mucosal lining and wall.

The symptoms produced by the cysts are due to pressure on the adjoining thoracic structures. The commonest are dyspnea, cyanosis and cough. They usually appear soon after birth. In the authors' case as well as in 6 others reported in the literature, symptoms alternated with periods of comparative comfort. When thoracic cysts are suspected, careful roentgenologic examinations may be helpful. If the cyst is not demonstrated, the authors suggest aspiration of the cyst with introduction of a radioopaque substance.—*R. S. Bromer.*

#### ABDOMEN

BAUMANN-SCHENKER. Über Paramyloidosis. (Paramyloidosis.) *Radiol. clin.*, Jan., 1946, 15, 68.

Paramyloidosis is a disease the cause of which is unknown. It is probably due to a disturbance of protein metabolism. In contrast with ordinary amyloidosis none of the known causes of amyloid can be found, such as chronic suppuration due to tuberculosis, syphilis, etc. The usual places of deposit, such as the spleen, liver and kidneys, are free of it, and it is generally the heart muscle, the intestine, the subcutis, the parotid, the thyroid and the gastrointestinal canal that are affected. Histologically paramyloid differs from ordinary amyloid in that the staining reactions are different and there is no metachromasia.

Roentgenologically the changes in the gastrointestinal canal are of the greatest interest, as the deposits in other places can as a rule not be demonstrated by roentgen examination.

A case is discussed in a patient who died at the age of forty-one. There was a very extensive and diffuse amyloid infiltration of the stomach, esophagus, and small intestine. The mucous membrane folds were greatly swollen; in the small intestine they were as large as stomach folds, the intestine was rigid and peristalsis af-

fected. In extreme cases no peristaltic activity can be seen on the roentgen screen. There were no roentgenologically demonstrable deposits in the colon and pathological examination did not show any amyloid deposits there.

Differential diagnosis is discussed. The case was confirmed on autopsy. (Author's abstract.) Translated by *Audrey G. Morgan.*

ETTER, H. Über die Röntgendiagnostik des terminalen Ileum. (Roentgen diagnosis of the terminal ileum.) *Radiol. clin.*, Jan., 1946, 15, 62-67.

The position and course of the terminal ileum shows three types: it often rises from the pelvis parallel to the cecum and empties into the median wall of the cecum at an angle acute downward. Almost as frequently it runs from medially and below to laterally and upward and empties into the cecum straight or slightly twisted. Somewhat less frequently it forms a large ascending arch which empties into the cecum at an acute angle. The large arch may change its position and stretch as a result of peristalsis alone, but otherwise the types remain constant. The terminal ileum shows very marked peristalsis which pushes the contents through Bauhin's valve into the cecum. When the mucous membrane folds run parallel with the course of the intestine, transportation is furthered and when they run transversely it is retained and mixed. Peristalsis is a function of the muscularis mucosae and the transportation or retention relief is brought about by the autoplasmic function of the muscularis mucosae.

There is greater variation of tonus in the terminal ileum than in other parts of the intestine and therefore caution is necessary in diagnosing terminal ileitis. Illustrative roentgenograms are given.

In the discussion Mathez said that he disagreed with the author in regard to the three constant types of form of the terminal ileum. He has seen two or all three of these forms succeed each other in the course of a single examination.—*Audrey G. Morgan.*

PLENGE, H. E., and ROSS, J. N. Roentgenologic examination of the stomach with patient under sodium pentothal anesthesia. *South. M. J.*, March, 1945, 38, 183-185.

The importance of differentiating between spasm and organic infiltration of the prepyloric

portion of the stomach is recognized by all roentgenologists. The fact that pilocarpine, atropine, belladonna, and other antispasmodics do not relax spasm in this portion of the stomach has been repeatedly demonstrated. The author believes a general anesthetic may help differentiate spasm from organic infiltration. He used sodium pentothal intravenously in 3 patients in whom prepyloric antral spasm had been repeatedly demonstrated and found that the spasm relaxed when the anesthetic took effect. The author believes general anesthetics should be used much more frequently in patients suspected of having antral spasm rather than organic infiltration.—*Philip J. Hodes.*

HUDSON, PAUL L. Echinococcus disease; report of three cases of calcified cysts of the liver. *South. M. J.*, Sept., 1945, 38, 584-589.

The author reports 3 cases of calcified echinococcus cysts of the liver encountered in patients who were natives of the state of Georgia. All revealed well defined calcified masses in the region of the liver by roentgen examination.

Whereas the disease has usually been associated with sheep, there is good evidence now that hogs and cattle are important intermediate hosts for the parasites.

In discussing diagnostic criteria, the dangers of diagnostic puncture of the cyst are considered. Not only can this puncture spread the infection but it may be misleading as clear fluid may be obtained from the cyst which will contain no characteristic hooklets or scolices.

Significant eosinophilia is reported in only about 25 per cent of the patients with echinococcus disease.

Immunological responses developed by the hosts have been utilized as diagnostic aids. Considerable work has been described concerning serum precipitin and complement fixation reactions. Skin tests for echinococcus disease have been reported positive in 90 per cent of proved cases, although false positive reactions are not rare. Old cysts often fail to react in positive manner to skin tests because the immune response of the body is often lost after the cyst degenerates. The importance of using fresh cyst fluid for these tests is re-emphasized.

The article contains excellent roentgenograms revealing the various types of calcified cysts found in and around the liver.—*Philip J. Hodes.*

MORRISON, M. C. Radiological findings in lesser sac effusion. *Canad. M. Ass. J.*, May, 1945, 52, 474-477.

Of the two cases presented, in one the lesser peritoneal cavity contained considerable air as well as fluid; in the second, the space was occupied by bile following cholecystectomy.

At postmortem examination, the first patient proved to have a congenital diverticulum of the left half of the diaphragm which contained the fundus of the stomach as well as spleen. Apparently, strangulation and perforation of the stomach with extravasation of gastric contents into the lesser peritoneal cavity had taken place. The roentgenogram made in the anteroposterior projection revealed a large collection of air in the gastric region which had the appearance of a markedly distended stomach. The splenic flexure of the colon was displaced downward to the iliac crest.

The second patient had had a cholecystectomy for an acute cholecystitis. Approximately three months after the original operation, the patient returned to the hospital complaining of pain in the left shoulder and epigastric distress. At operation, approximately 1,000 cc. of brownish-yellow fluid was drained from the lesser peritoneal sac.

The roentgenograms of the chest made prior to operation revealed a pleural effusion in the left chest, secondary to the subphrenic infection. The films of the abdomen revealed a barium-filled stomach displaced posteriorly as well as somewhat inferiorly and toward the midline. Definite evidence of extrinsic pressure upon the stomach was clearly defined.—*Philip J. Hodes.*

#### SKELETAL SYSTEM

PRIDIE, KENNETH H. A new method of treatment for severe fractures of the os calcis; preliminary report. *Surg., Gynec. & Obst.*, June, 1946, 82, 671-675.

In the past a fracture of the os calcis was a relatively rare injury, confined very largely to window cleaners. Modern warfare, however, with the introduction of the torpedo, land mine, paratroop landings, and other features of warfare, has increased not only its absolute incidence, but also the relative frequency of the severe, highly comminuted type. Despite the most energetic treatment, the resultant disability remains a serious one. Patients are left with persistent pain, stiffness, inability to walk

over rough ground or do ladder work, or indeed any form of hard manual labor.

In those cases in which the subastragaloid joint has not been affected, early movements and freedom from weightbearing for six weeks produce good results, and the patients are able to return to their preaccident occupations. But in others, even when the fracture does not appear to be a serious one, subastragaloid arthritis develops out of all proportion to the roentgen findings so that the end-result is much worse than would be expected, the disability consisting, as before, of pain and stiffness. Despite individual variations in tolerance to pain, the findings in a large number of patients are remarkably consistent.

#### *Forms of Treatment.*

1. Boehler's method of applying skeletal traction to the back of the os calcis and at the same time compressing the bone from side to side by means of a redresseur has not produced any better end-results nor has it prevented stiffness or subastragaloid arthritis.

2. Late arthrodesis of the subastragaloid joint proved so disappointing in the author's hands that it was abandoned and early arthrodesis was tried.

3. However, early arthrodesis is difficult for the soft tissues are badly bruised and infiltrated with blood, while the os calcis is not so much a bone in fragments as a bag of bones. The satisfactory removal of the articular cartilage from the subastragaloid joint surfaces is a procedure of great difficulty.

4. In the normal leg and foot three joints provide the necessary movements which allow the foot to adapt itself to the ground and permit easy walking. They are the ankle, the subastragaloid and the midtarsal joints. When the latter two become stiff it is impossible for the individual to use his foot in the normal way because only simple dorsiflexion and plantar flexion are left to him. As a result of this experience it was decided to perform *total removal of the os calcis for the seriously comminuted type.*

*After Treatment.* The foot is immobilized in the original plaster for one month. The position of plantar flexion is maintained to ensure relaxation of the Achilles tendon so that its new attachment to the plantar fascia is not strained. At the end of four weeks the sutures are removed and active nonweight-bearing exercises are commenced. The important exercises are inversion, eversion, and circumduction. Post-

traumatic edema is prevented by insisting that the leg be not allowed to hang down during the weeks immediately following removal of the cast except during periods of exercise. When the patient feels able to walk he is encouraged to do so. The average period is about six weeks. It is important to see that he is taught to walk correctly and without a limp.

*Results.* This new method of treatment of fractures of the os calcis has been performed 15 times to date and the 2 cases reported in this article were the first and therefore have been observed over a considerable time (3 years and 2 years respectively).

*Conclusions.* The results of this operation have been gratifying. It probably should be reserved for the severely comminuted fractures and, like other excisions of bones in the foot, it is a somewhat difficult operation because of the strong ligaments attached to the bone. Unless one is careful to avoid a postoperative hematoma there is risk of sepsis. The operation should be performed as soon as possible after the injury in order to prevent intrafascial tension from bleeding and edema which causes ischemia and subsequent congealing of the intrinsic muscles and leads to stiff midtarsal joints and stiff toes.

The chief advantages of this method are:

1. Freedom from pain.
2. Good range of inversion and eversion.
3. Mobility of the whole foot.
4. Good toe action.
5. This operation will undoubtedly save many an injured foot from amputation.—  
*Mary Frances Vastine.*

BRAY, ERNEST A., and FITTS, WILLIAM T. Gunshot fractures of the femoral shaft. *Surg., Gynec. & Obst.*, Jan., 1946, 82, 91-100.

This study is based upon a series of 82 cases received at a General Hospital during the campaign in North Burma from October, 1943, to August, 1944. It includes all complete compound fractures of the femoral shaft, some of which were comminuted into the knee joint.

*Summary of Important Points.* The function of the forward surgical groups is the treatment of shock and hemorrhage, adequate debridement of wounds, institution of prophylactic chemotherapy, immobilization of fractures, and early evacuation. Definitive treatment of fractures should be reserved for the fixed installations.

In the prevention of infection, the most important single factor in the early treatment of wounds is the adequacy of the debridement.

A spica plaster is a satisfactory method of temporary immobilization. Nonpadded plasters should not be used, but if used by necessity, they should be split through their entire length before transportation.

No ankle or instep hitches should be used in connection with Army leg splints.

Early inspection of the wound at the fixed medical installation is advisable to rule out infection, especially by gas-forming organisms. Afterward, dressings should be reduced to a minimum.

Incision and drainage should be instituted early when there are knee joint infections or deep subfascial abscesses. Dependent counter incisions are necessary.

Circulatory impairment is serious and not uncommon. It must be recognized early and the cause eliminated.

Anemia, malnutrition, and the effects of exposure must be combatted. Early replacement of blood loss by whole blood transfusion improves the general condition of the patient and helps to prevent infection.

Balanced skeletal traction suspension is a very satisfactory method of treating these patients in a fixed installation.

When traction suspension is used, the possibility of gravitational abscesses should be watched for and early drainage should be accomplished.

Kirschner wires through the lower femur and upper tibia proved very satisfactory, and there were no untoward effects. Each location has its advantages for certain types of fracture. The wires should be changed from one location to another when indicated.

Posterior angulation of lower femoral fractures can be corrected by placing the wire through the tibial tubercle and making the traction in the line of the tibia instead of the femur.

Repeated roentgenologic examination is essential in treating these cases by traction suspension. Overpull must be avoided.

When there is associated knee joint infection, flexion of the patient's knee in the traction suspension apparatus should be limited to 5 degrees.

Traction should be continued until there is roentgenologic evidence of bone union. The

average time for bone union was twelve weeks. Knee joint motion should be encouraged after eight weeks.

Forceful manipulation of the knee is of no value and may do harm. Wedge plasters, however, are of considerable assistance in the relief of persistent joint stiffness.

Secondary hemorrhage from a wound, however slight, is a positive indication for immediate exploration.

Refractures usually heal, but convalescence is considerably prolonged thereby. Patients with precarious union should be kept in suspension for an added length of time. Afterward, leg braces should be used when they are available.

Bone infection did not predispose to non-union, nor did it significantly delay the time of bone union as seen on the roentgenograms. However, refracture in these cases must be avoided by a longer period of immobilization than in the clean cases.

The osteomyelitis seen in these cases was localized, minimal, and easily controlled. It is possible that it was limited by the use of sulfonamides.

Retained metallic foreign bodies did not appear to predispose to bone infection.

There was a mortality of 4.9 per cent. Bone infection of some degree was noted in 28 per cent. Bone union occurred in 96 per cent of the survivors. The known functional end-results of 67 followed cases were good in 67 per cent, fair in 24 per cent, and poor in 9 per cent.—*Mary Frances Vastine.*

MACDONALD, IAN, and BUDD, JOHN W. Osteogenic sarcoma; roentgenographic interpretation of growth patterns in bone sarcoma. *Surg., Gynec. & Obst.*, Jan., 1946, 82, 81-86.

The appearance of a bone tumor at a given time depends upon the balance between neoplastic activity (osteolysis), and the degree of cortical and medullary reaction (sclerosis), as well as the absence or extent of ossification and calcification. The "sun ray" appearance of many osteosarcomas may be due either to new bone formation or calcification in parallel striae and may be seen in chondrosarcoma and even in neoplastic metastatic lesions of bone. Even Codman's time-honored reactive triangle may be seen in chronic periostitis. In short, "typical" roentgenographic features are a reflection of

growth characteristics rather than an indication of tumor types, a kinetic rather than a static concept.

The observations presented here are part of a study of 118 cured cases of bone sarcoma, and a smaller number of uncured cases, from the Registry of Bone Sarcoma of the American College of Surgeons.

*Definition.* "Osteogenic sarcoma" applies to those sarcomas arising in the connective tissues of bone, distinguishing this numerically large group from those of less frequent incidence arising in hematopoietic, endothelial, and adipose tissue elements of the medulla.

*Proposed Division of the Connective Tissue Sarcomas.* (1) Osteosarcomas—bone-producing sarcomas. (2) Chondrosarcoma. (3) Fibrosarcoma.

The roentgenologist may make a diagnosis of osteogenic sarcoma with reasonable expectation of verification if there is evidence of a cortical, malignant tumor. Roentgenographic criteria are highly unreliable in attempting a more accurate differential diagnosis of osteogenic sarcomas.

*Osteosarcoma.* This is a highly lethal disease. It arises in the metaphysis and may be predominantly sclerosing or osteolytic. The former type is the more common and it may be peripheral or central in origin. The peripheral sclerosing is the classical type in which the tumor early elevates the periosteum, usually with dense radiating striae and Codman's reactive triangle. With continued growth there is progressive sclerosis of the cortex and medulla, and soft tissue extension in advanced cases. The only sign of central sclerosing osteosarcoma may be a dense obliteration of the cortical striae while secondary destruction in the medulla produces a mottled appearance.

The pure osteolytic form of osteosarcoma is the old "telangiectatic bone aneurysm" and represents a rare and extremely anaplastic form. There is irregular, expansile destruction of the cortex, little or no periosteal reaction. There may be early perforation and bulky soft tissue masses, invasions of the epiphysis and adjacent joint.

*Chondrosarcoma.* Chondrosarcoma is less malignant than osteosarcoma but more so than fibrosarcoma. It arises in the ends of the diaphyses of long bones, in flat bones and verte-

brae. There are two well defined forms, peripheral and central. In the former, an irregular, productive periosteal growth is the earliest stage. Calcification is extremely common in chondrosarcoma. It may early perforate the periosteum and produce bulky, lobulated, soft tissue tumors, or blotchy, irregular masses of calcifying neoplasm. Calcification may also occur in linear, striated style, simulating peripheral sclerosing osteosarcoma.

The central type of chondrosarcoma often produces irregular areas of rarefaction, usually with adjacent reactive sclerosis, forming a shell around the tumor. Eroded areas may appear cystic and resemble fibrosarcoma. Sclerosis and calcification may predominate in the central type, with dense ivory-like obscuration of architecture.

*Fibrosarcoma.* This is the most benign form of the connective tissue sarcomas. It may arise in any part of the long bone including the epiphysis. It is a frequent form of sarcoma of flat bones. The most common form is the osteolytic. In its early stage its origin may be evident as medullary, cortical, or periosteal. It may enlarge to form a single predominantly destructive lesion, with little or no reactive sclerosis or periosteal thickening. These tumors are usually non-expansile. Roentgenographic evidence of extension is frequently that of an irregular spotty osteolytic process with or without sclerosis of adjacent bone. Multiple cyst-like areas are not uncommon and should not be confused with giant cell tumors. These forms are frequently slow in growth and five year cures have been obtained by amputation after repeated local operations.

There is an advanced diffuse osteolytic form of fibrosarcoma, less common, which affects one-third or more of a large bone, in which there are linear and circumscribed areas of rarefaction with intervening strands of sclerosing bone. The result is a ragged, moth-eaten appearance which may simulate Ewing's sarcoma.

In any soft tissue fibrosarcoma, ossification may occur. Most ossifying fibrosarcomas in bone in the past have been diagnosed as osteosarcoma.

*Differential Diagnosis.* The simulation of primary bone tumors by metastatic lesions has been observed repeatedly.—*Mary Frances Vastine.*





J. BENNETT EDWARDS  
President of the American Roentgen Ray Society  
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## TRANSITORY FOCAL PULMONARY EDEMA AND EOSINOPHILIA (LÖFFLER'S SYNDROME)\*

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IN 1931, Löffler of Zürich first drew attention to a hitherto undifferentiated condition, not identifiable with any known disease, characterized by transitory roentgenological lung shadows and pronounced blood eosinophilia, with for the most part an extraordinary absence of symptoms and clinical signs. He then reported 5 cases, 2 of which he regarded as certainly not tuberculous, but probably some form of atypical pneumonia; the other 3, manifesting positive von Pirquet reactions may have been early tuberculous infiltrates despite the lack of other corroborative evidence.

At the Fourth International Congress of Radiology in Zürich in 1934, Löffler reported an additional 12 cases; and in 1936, before the Swiss Antituberculosis Association, brought his total number to 51. At this meeting other observers contributed to a total of 100 cases, which for the most part had been discovered on routine check-up examinations by roentgenoscopy and roentgenography at sanatoria and chest clinics in Switzerland.

### DESCRIPTION

Fourteen of Löffler's 51 cases, for the most part discovered accidentally in the

course of serial roentgenoscopies and environmental researches, had no complaints. The majority did have mild complaint of tiredness or fatigue. Slight cough was not unusual. Some had an irritating cough. A few had mild fever for a few days, but in 30 there was none.

These patients typically did not appear to be very ill. Physical signs of disease were usually lacking entirely, or were vague. At most, slight impairment to percussion was noted, with harsh vesicular murmur and some crepitations, but never bronchial or blowing breathing, rarely a friction rub. In none of Löffler's cases were there physical signs of consolidation. (This would make one doubt that Freund and Samuelson's case rightfully belongs in this category. More probably its condition was a resolving pneumonia in a known asthmatic with eosinophilia.)

Sputum, if any, occasionally showed eosinophiles, never tubercle bacilli nor *Ascaris* larvae, although searched for assiduously. Two cases reported blood in the sputum.

In no respect was the patient's clinical appearance found to correspond to the severity suggested by the chest roentgeno-

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gram. Characteristically the pulmonary shadows are variable in density and extent, without well-defined or circumscribed margins, seeming to fade off into the surrounding parenchyma, develop rapidly (three to eight days) and quickly disappear. These transitory, successive lung infiltrations may occur anywhere in the pulmonary areas, unilateral or bilateral, apical or basal, single or multiple. The fugitive nature of these patches of increased density, coming and going within a few days, disappearing in one area to appear in another lobe or lung, is remarkable. Löffler insisted that they must not remain in any one site for more than seven to ten days in order to conform to the pattern of the syndrome.

Concomitantly, a pronounced increase in blood eosinophilia constitutes the third major feature of the syndrome. This accompanying phenomenon, varying from a moderate increase to very high (maximum 66 per cent of 14,300 leukocytes in Löffler's series), waxes and wanes with the shifting pulmonary shadows, tending to lag in its cycle somewhat behind the fluctuations in magnitude of pulmonary abnormality. The white blood cell count in Löffler's series varied from normal to 15,000. Sedimentation rate is increased but little, if at all, in most of the cases. Values up to 50 mm. in one hour have been recorded.

The clinical syndrome therefor has these three main features:

- (a) Very slight to no involvement of general health.
- (b) Fugitive, shifting pulmonary roentgenographic changes of marked variability.
- (c) Concomitant but variable increase in blood eosinophiles.

Each of these three characteristics is striking when considered in the light of the implications of the other two. The relative state of well-being is perhaps the most notable of all, for these patients do not appear ill, and the course of disease is fundamentally benign. It must be emphasized that a diagnosis of Löffler's syndrome cannot be

made upon a single roentgen examination of the chest, although it may be suspected from the relatively atypical character of the individual pulmonary changes. Serial roentgenograms periodically over an interval of days will be required to give witness to the fugitive and shifting character of the lung changes.

#### ETIOLOGY

It may be stated at the outset that the exact etiology is in considerable doubt. The benign course of the disease precludes a pathological study of the lesion, unless by some fortunate accident an opportunity should be presented. Speculation, however, within the bounds of clinical and physiological knowledge leads us to the consideration of several interesting possibilities.

Löffler himself believes that some of these cases certainly are related to tuberculosis, and that the shadows may be regarded as early tuberculous infiltrations. In a second group the etiology is obscure, and a differential diagnosis from tuberculosis is difficult to establish. Then there is a third considerable group in which the cases are certainly not of a tuberculous nature. Here, in Löffler's opinion, we are dealing with a pneumonia-like reaction in an allergic individual—a form of abortive pneumonia which may be produced by various stimuli. In other words, the transitory infiltrates are the responses on the part of a shock-organ (the lung) in a special allergic state to a variety of allergenic insults, the response of the tissue depending not so much on the nature of the allergen as on the presence of the allergic state itself, as if there were a uniformity in the reaction of the tissues to allergenic irritants of various kinds.

The case for "allergy" to explain this condition is at least suggestive. To begin with, the transitory manifestations in the lung coupled with the pronounced eosinophilia suggest an edema—a sort of internal or visceral angioneurotic edema affecting in particular the interalveolar structure of the lung with its rich and complicated capillary

network. Furthermore, the personal history of many of these patients contains evidence of past or associated manifestations of allergy. Rohner, reporting on his own case, tells of angioneurotic edema of the face appearing as the syndrome subsided and lasting for some days. Hansson's patient developed typical asthma. Cohen's patient was afflicted with migraine, and, as will be seen in our own case, allergy was a definite and determining factor.

Analogy is drawn by Löffler with erythema nodosum in which there is a transitory exudative inflammation or phenomenon as an allergic manifestation of visceral tuberculosis, without the presence of the infecting agent, i.e. a "tuberculid" or "microbid." So the transitory lung infiltrate might be accounted for as an internal or visceral "erythema nodosum." Löffler considers the condition as a "microbid" of the lungs, and therefore often as a "tuberculid" of the lungs analogous to erythema nodosum; and he considers the separation of these cases into a distinct group as fully justifiable. Erythema nodosum is of course seen in other infections than tuberculosis, e.g. rheumatic fever, chronic ulcerative colitis, etc., where such manifestations are held to be due to a bacterial allergy to the specific organism.

The constant finding of eosinophilia, besides suggesting allergy, led some observers to the idea that helminthiasis might be an important factor. It is well recognized that *Ascaris* larvae in their migrations may set up perifocal reactions in the lungs, producing transitory shadows belonging to the same general type. Wild of Basle, the chief proponent of this view, reported on 14 cases in children with *Ascaris* ova found in the stools in 4; but the eosinophiles seldom exceeded 10 per cent. Löffler himself was unable to find any evidence of *Ascaris* infestation in his case, and judged that this was not a likely explanation except in rare instances.

The question of tuberculosis is much more difficult to answer; and there are a number of facts which favor this hypothe-

sis. Cohen has emphasized how impossible it is to view any single film in these cases without being immediately impressed with the idea of a tuberculous origin, so identical are the roentgenologic aspects. Also, some of the Löffler shadows strongly suggest an early tuberculous infiltration, a condition which Spiro and Becker state is not infrequently accompanied by a moderate blood eosinophilia. So it may be easy to fall into error.

Furthermore, a few of these cases have subsequently developed frank tuberculosis—one only in Löffler's series, a year later. Leitner, under the designation of "hyperergic infiltration," in patients with tuberculosis has described shadows resembling very closely those under consideration, and this not infrequently—14 such in 580 cases. Oeri of Davos has emphasized the frequency with which the syndrome is discovered in patients with tuberculosis since, in 120 patients during a period of only four months, he found the condition in 5, all of whom had marked tuberculosis of the lungs, 3 with cavities.

It must be borne in mind, however, that these authors, working in sanatoria and having serial roentgenograms or roentgenoscopy on each patient from time to time, were undoubtedly favorably situated for the detection and recognition of these transitory shadows in tuberculous subjects, and perhaps for this reason were more likely to be influenced by the idea of a tuberculous origin.

Against the diagnosis of tuberculosis, the rather rapid and essentially benign course, with lack of calcification, must be taken into account, as well as the undoubted fact that only very rarely did tuberculosis supervene or were tubercle bacilli recovered.

With regard to tuberculin, in Löffler's 51 cases, the von Pirquet reaction was consistently negative. With the Mantoux reaction, of 37 cases so tested, 13 were negative in spite of there being no children in the group, and 24 positive, half of them but weakly so. Of the 14 children reported by

Wild, 12 had negative von Pirquet reactions. These figures may be considered as not very significant, if indeed they show any departure from those found normally in the population.

One further point concerns the blood eosinophilia which, while not uncommon in early tuberculosis, never assumes the proportions found in Löffler's syndrome. In the tuberculous cases, the eosinophiles are but moderately increased—in the neighborhood of 4 or 7 per cent, and only rarely as much as 10 per cent. It may be repeated that in only 1 of Löffler's own cases did a secondary tuberculous infiltration supervene one year after the eosinophilic infiltration.

Mention also may be made of the seasonal incidence to which some observers have called attention, many cases of the syndrome having occurred during the hot months of June, July and August. In Shanghai, Engel described as "springtime anaphylactic pulmonary oedema" a condition occurring in May and June each year at the time of privet pollination, characterized by coryza, polymorphous transitory lung shadows, blood eosinophilia, mild signs and a good prognosis, and therefore closely resembling Löffler's syndrome, except for a peculiar and characteristic type of sputum of orange color and metallic taste. Engel's tests with privet pollen were consistently negative, however, and Löffler himself in the vicinity of Zürich was never able to observe any increase of the syndrome cases during the period of heavy privet pollination.

#### CASE REPORT

H. S., male Hebrew taxi driver, first came to our attention at the Allergy Clinic of the Royal Victoria Hospital September 11, 1940, at the age of thirty-four. He complained of asthmatic attacks since September, 1939, occurring about every three weeks in association generally with a "head cold," but since June, 1940, the condition had been more constant with much sneezing, blocking of the nose and eye irritation throughout the summer, more particularly since August. More recently, the nasal discharge had been heavy and discolored, cough,

with much greenish sputum, oppression on the chest and "choking up," being prominent symptoms.

Physical examination revealed very little; percussion was normal, breath sounds vesicular throughout and no rales. The sputum yielded a heavy growth of *Haemophilus influenzae* and a vaccine was prepared. Positive tests were obtained to the ragweeds, pyrethrum, house dust and orris.

His progress as an out-patient was unsatisfactory and on November 17, 1940, he was admitted to the Medical Ward with the provisional diagnosis of ragweed pollinosis, asthmatic bronchitis, and bronchiectasis.

The personal history, much of which is pertinent, was as follows. Born in Montreal in 1905; except for measles, he was perfectly well until the age of fourteen when he left school to work in a clothing factory, and shortly after "began to have nose trouble." The following year (1920) an attack of "influenza" was followed by a troublesome cough for ten months. His parents consulted a well-known physician, who suspecting lung abscess because of persistent cough and sputum for over a year, and hemoptysis in August, 1921, advised hospitalization in November of that year. At first no abnormal signs were detected but later there was demonstrated in the right chest anteriorly a triangular area of impaired resonance with crackles. Roentgenograms were reported to show "a triangular shadow in the middle third of the right lung with apex towards the periphery." The sputum averaged 3 ounces a day, five separate examinations revealing no acid fast bacilli, nor any elastic tissue. One small hemoptysis was noted during this admission. He was discharged with a diagnosis of "bronchiectasis right lung."

Some time later, he came under the care of an otolaryngologist, and for over a year (1924-1925) received weekly bronchoscopic aspirations for the suspected bronchiectasis. As a result of this treatment, he improved and was able to do some work, although during this same period he suffered from bilateral chronic suppurative otitis media with subsequent disturbance of hearing.

Several years later, in 1933, a diagnosis of "duodenal ulcer" was made by his family physician on the basis of heartburn, epigastric distress two to three hours after eating, hematemesis and tarry stools; with roentgen confirmation. Steady improvement ensued on bed rest and a Sippy regimen. Seven months later he suffered

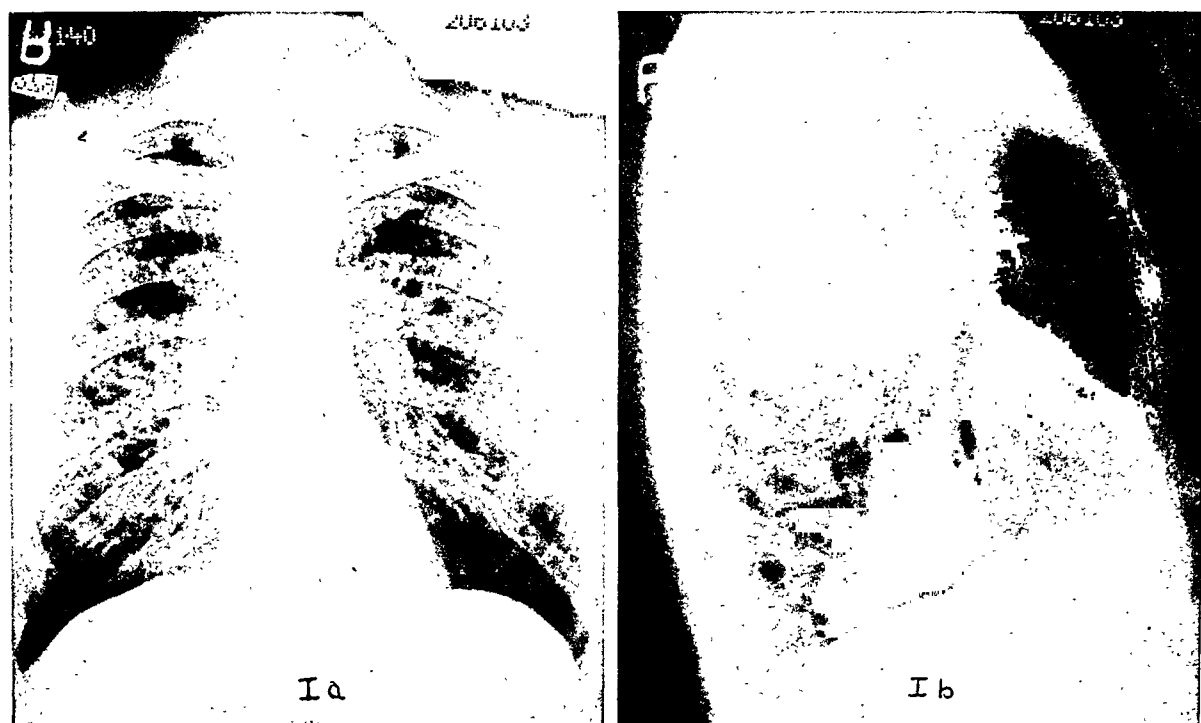


FIG. 1. November 19, 1940. *a*, frontal projection. Old tuberculous scars in each apex with calcification; diffuse patchy parenchymal increased densities in each axilla, both lung fields and parahilar areas. Patient's clinical lack of severe illness seemed incompatible with roentgen evidence of abnormality. *b*, lateral view. Note obscuration of normal markings, emphysematous substernal aperture and basal areas.

a relapse, but again responded favorably on resumption of routine treatment.

In November of that year, complaints of weakness, tiredness, pain in the right chest and sputum led to his admission to a sanitarium for incipient tuberculosis. Bed rest for three months was followed by part-time work in the institution. During this twelve month period, he had no fever, the sputum was negative for tubercle bacilli, but the roentgenograms were considered to show "moderately advanced tuberculosis, apparently not active." Blood eosinophilia, up to 6.5 per cent, was reported.

Returning to Montreal, he was able to work for the next five years as a taxi driver. A fall on icy pavement (December, 1936) necessitated his admission to the Surgical Wards (Royal Victoria Hospital) with a fracture of the right tibia and fibula, which healed in a normal manner. During this admission, roentgen examination substantiated the diagnosis of a previous duodenal ulcer, gastric analysis revealing a moderate hyperchlorhydria.

In April, 1940, he was again admitted under otolaryngology for the removal of nasal polypi. Roentgenograms of the paranasal sinuses showed bilateral maxillary sinus disease, pos-

sible ethmoiditis and some sclerosis about the right frontal sinus, possibly due to chronic infection. Pus was returned on irrigation of the antra early in May; and bilateral radical antrotomy (May 18 and 23) showed a condition of extensive polyposis, with some pus and hyper-vascularity on both sides. During this admission, thorough search and culture (Lowenstein's medium) of the sputum had revealed no acid fast bacilli, but on two occasions *Haemophilus influenzae* was grown with some *Neisseria catarrhalis*.

The family history was of interest, as one brother had been treated for pulmonary tuberculosis, and another brother had ragweed hay fever.

During the three months period of observation in the medical ward (November 17, 1940–February 21, 1941), he presented the following salient features:

At no time did he appear very ill. Absence of clubbing seemed noteworthy considering the longstanding history of suspected bronchiectasis. Cough was a distressing feature with abundant nonfetid mucopurulent sputum occasionally bloodstreaked but with no bronchial casts or plugs, varying from 200 to 400 cc.

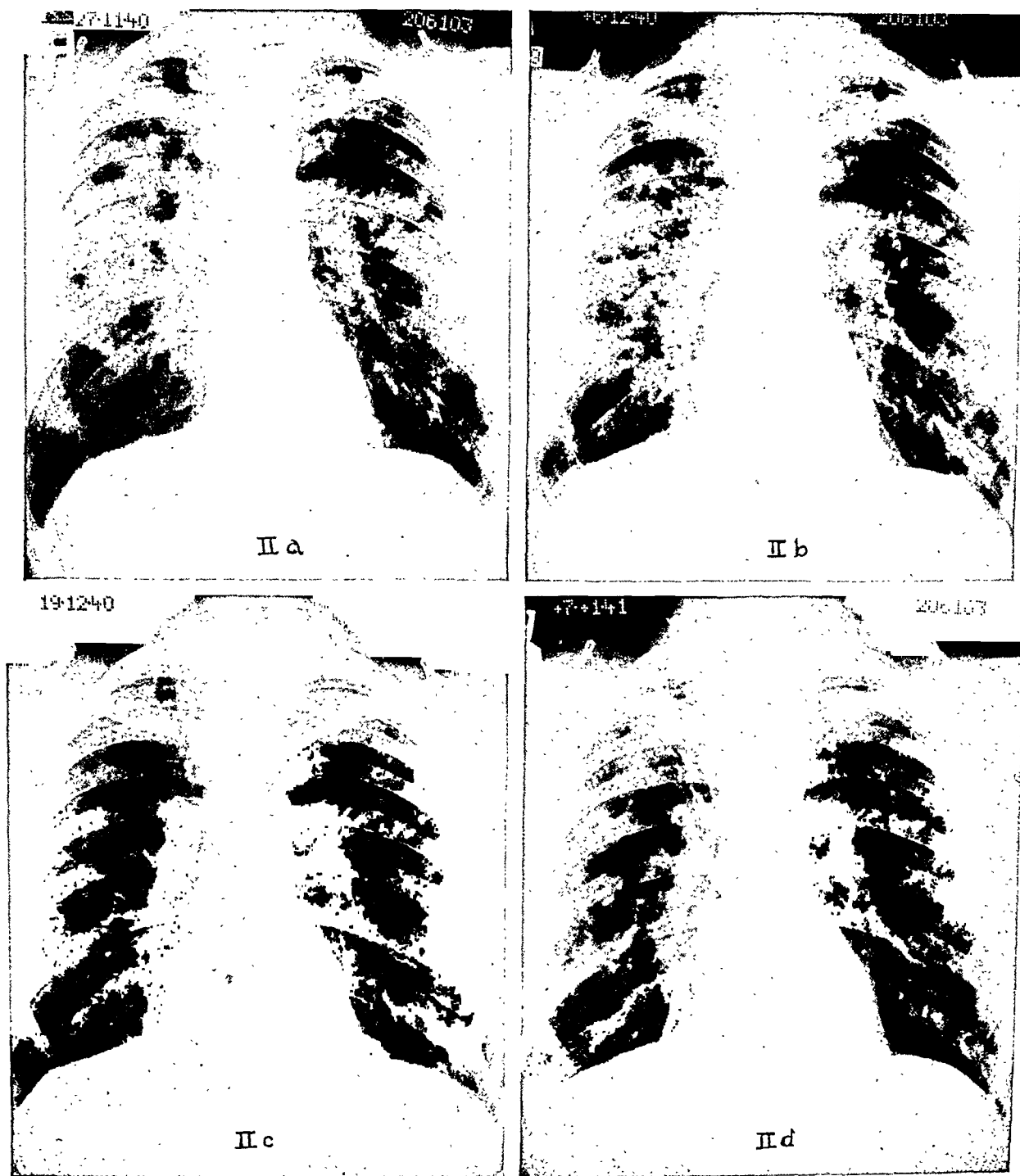


FIG. 2. *a*, November 27, 1940. More extensive and confluent shadows in right mid-lung field, less parahilar involvement on the left with more discrete changes in the left axilla. *b*, December 6, 1940. Considerable change in the ten days, fading on left, but exacerbation in right axillary lung zone; eosinophilia, 47 per cent. *c*, thirteen days later (December 19, 1940). Marked regression on both sides. Patient has been afebrile for six days; eosinophilia, 20 per cent. *d*, three weeks later (January 7, 1941). Left lung remains clear of all but old scars and a minimal area in lower axilla; recurrence of involvement in new portions of the right lung with obliteration of costophrenic angle. Eosinophilia, 56 per cent.

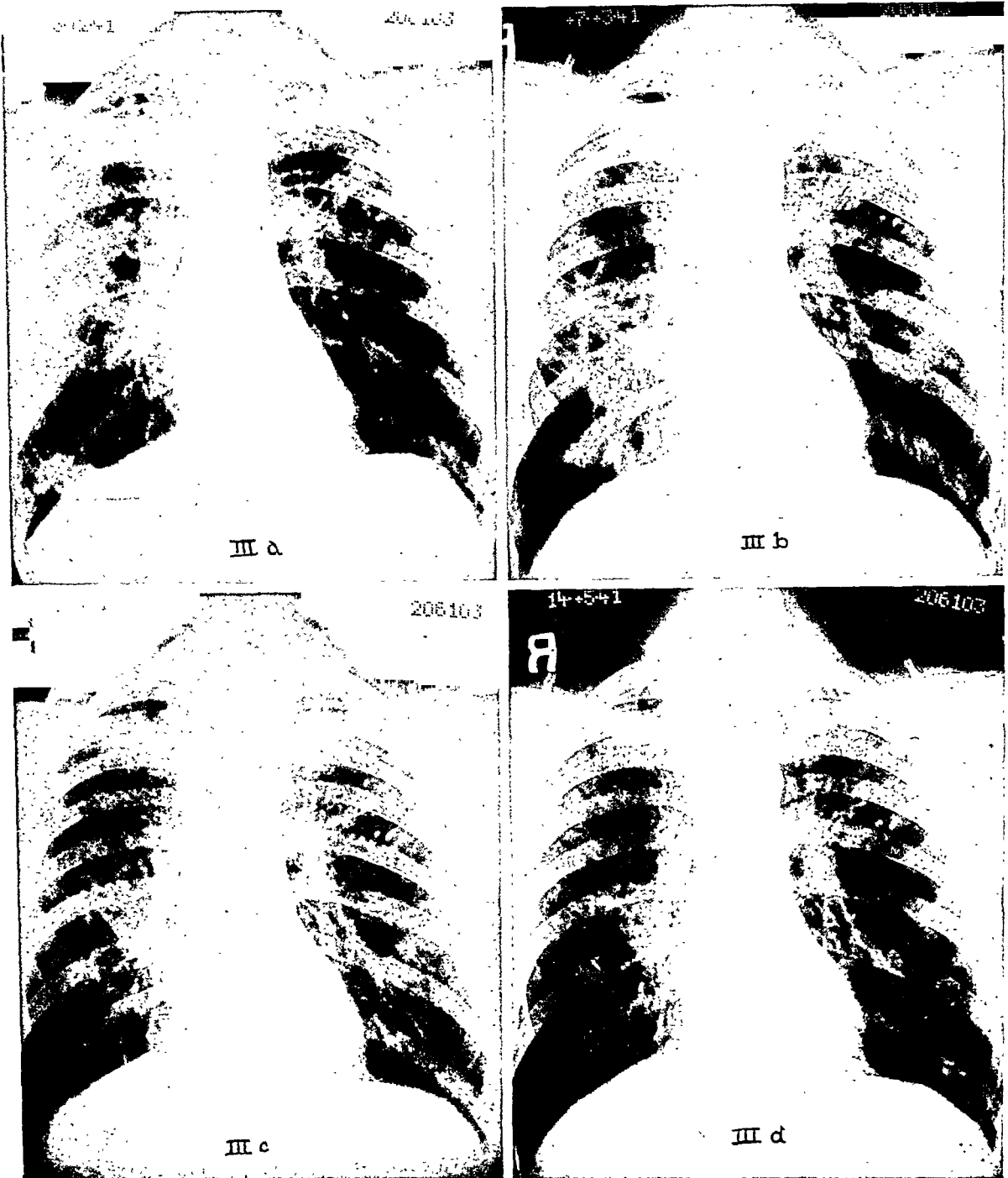


FIG. 3. *a*, February 3, 1941. New involvement of left upper axillary lung zone, clearing of right costophrenic angle, but diffuse coalescent changes throughout remainder of right axillary field. Eosinophilia, 40 per cent. *b*, one month later (March 7, 1941). Persistent and progressive changes in left upper axillary zone—some in mid-axilla; general clearing on right except in pectoral segment of upper lobe. Eosinophilia, 45 per cent. *c*, April 9, 1941. Persistent and increased change in pectoral segment of right upper lobe, clearing of the left generally, except evanescent areas in the mid-axillary area. Eosinophilia, 27 per cent. *d*, five weeks later (May 14, 1941). Almost complete clearing; some scattered minor residual areas remain with incomplete clearing of the right pectoral especially.

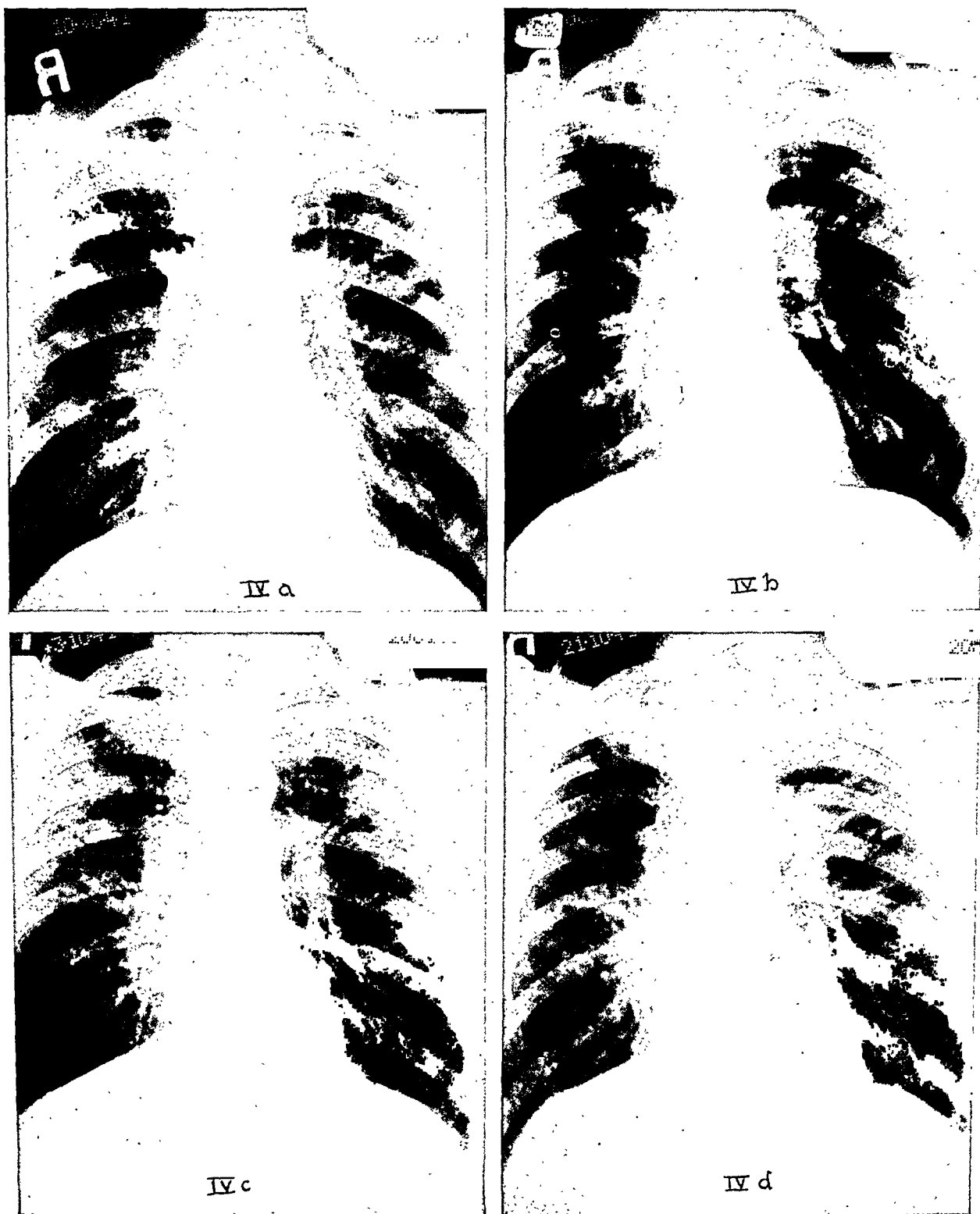


FIG. 4. *a*, June 10, 1941. Left axilla improving. Eosinophilia, 37 per cent. *b*, August 26, 1941. Virtually clear of any acute change. Old tuberculous foci unchanged. Eosinophilia, 23 per cent. Vaccine therapy (*H. influenzae*) had been completed. *c*, October 3, 1941. Has had some asthma. Recurrence of diffuse patchy areas both axillary lung fields, considerable on the left. Eosinophilia, 39 per cent. *d*, two and one-half weeks later (October 21, 1941). Clearing of the axillary areas, more on the right, but new involvement in right paracardiac zone. Eosinophilia, 22 per cent.

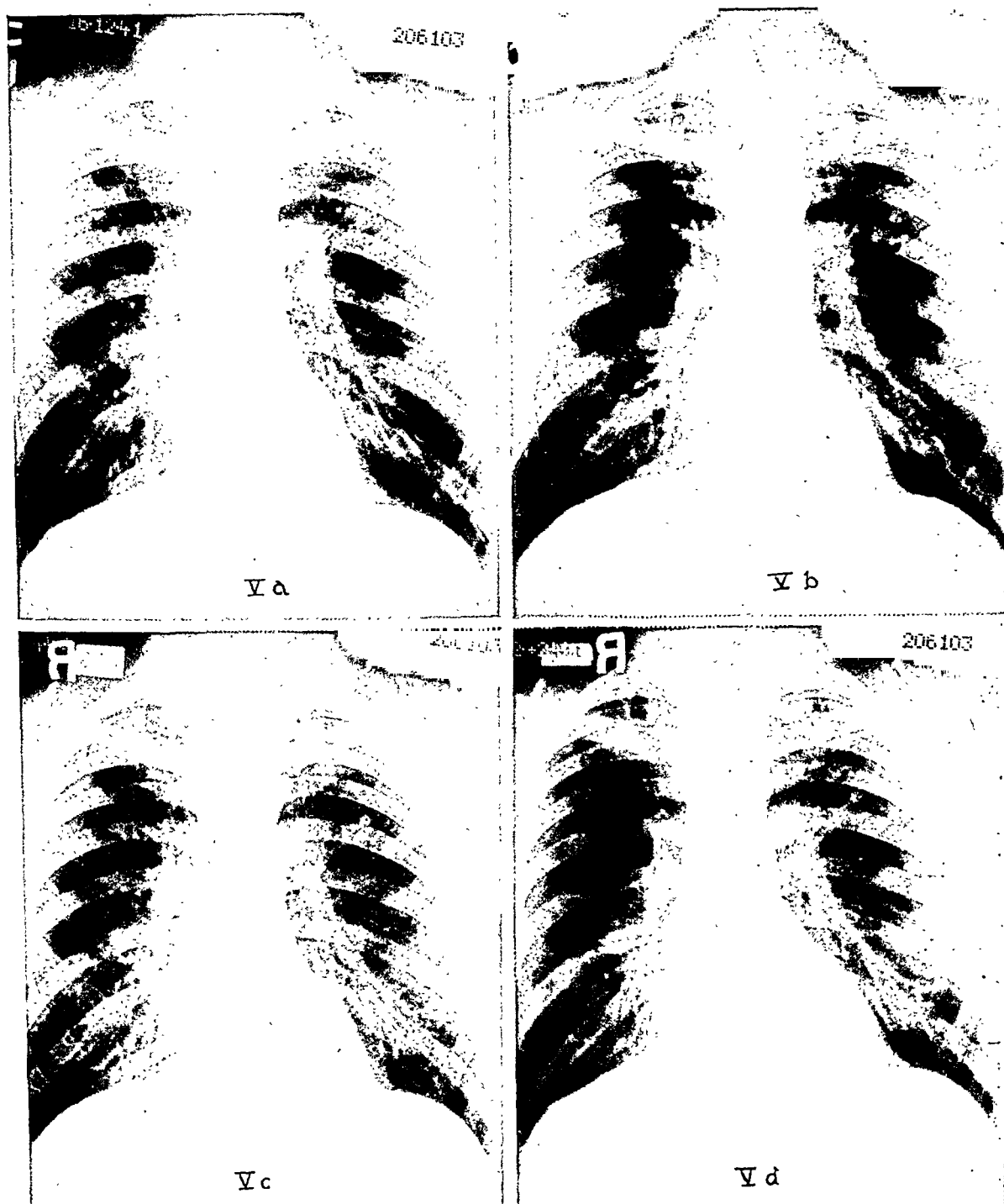


FIG. 5. *a*, December 16, 1941. Has had a clinical exacerbation, also showed drug allergy (sulfathiazol). Eosinophilia, 58 per cent. Slight recurrence of changes in left upper axilla, with some persistence in right paracardiac area. *b*, May 12, 1942. Has had nasal polypectomy and roentgen therapy to nose and paranasal sinuses. Severe reaction to tuberculin in March. Lungs almost clear. Eosinophilia now 13 per cent. *c*, April 19, 1943. Repeated interval chest roentgenograms had shown further clearing to this almost normal state, in spite of severe allergic reaction to *H. influenzae*. *d*, February, 1944. Essentially healthy chest, except for the old tuberculosis scars. No evidence of residuum from the other extensive and recurrent pulmonary changes. No evidence of activation of the old tuberculosis.

This excellent state of the patient's lung fields has been maintained relatively since May, 1942. There was no significant change visible on the last roentgenogram, February 6, 1946.



daily, on occasions reaching 500 cc. Irregular, somewhat relapsing and at times intermittent fever was noted for most of the time (99.2 or 99.4 to 101°F. with occasional rises to 103°F.), sulfathiazol apparently having no effect. There were four periods, five or six at a time when he was afebrile, as also the last fortnight. Physical signs were not distinctive. For the most part, particularly during the earlier period, they corresponded to an "asthmatic bronchitis" with

on skin test, and he was started on the desensitizing Kock vaccine on February 6. Mantoux 0.1 mg. positive.

He was retested with allergens, and again marked reactions were obtained to house dust, pyrethrum, feathers and the ragweeds, with one plus reactions to orris, tobacco and cattle hair, concerning which he was advised appropriately.

The chief interest, however, centered in the roentgenograms of the chest (Fig. 1, 2 and 3a)

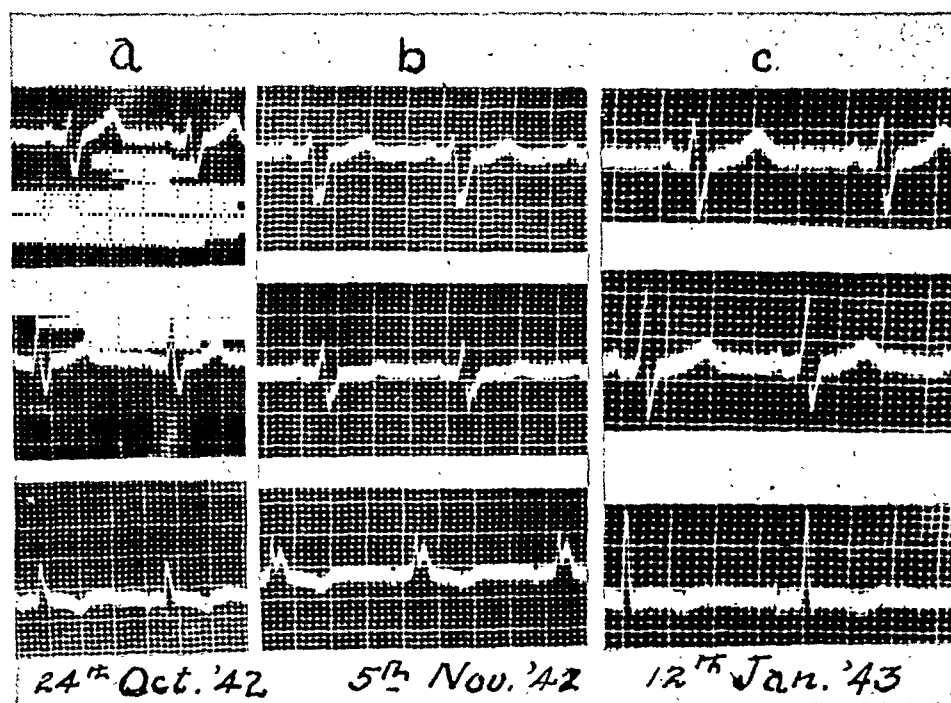


FIG. 6. Electrocardiograms. *a*, October 24, 1942. Right bundle branch lesion. *b*, November 5, 1942. Right bundle branch lesion, more definite. *c*, January 12, 1943. Right axis shift. Conduction time normal.

diffusely scattered rhonchi and some moist rales, with occasionally slight ill-defined local changes: the subsequent findings being very inconspicuous.

Exhaustive bacteriological studies were made on the sputum. At least twelve separate examinations were made for acid fast bacilli by direct smear, concentrate smears, cultures, and guinea pig inoculation. No evidence of tuberculosis was found. Yeasts, fungi, spirochetes and fusiform bacteria were searched for and on only one occasion were there a few spirochetes. General cultures, also of bronchoscopic pus, constantly yielded a heavy growth of *Haemophilus influenzae*. This organism showed complete agglutination with the patient's serum in a dilution of 1:32 and partial agglutination to 1:64. An autogenous vaccine was prepared, both Kock and formolized giving quite a marked reaction

which, in addition to inactive tuberculous lesions in the left axillary zone and both apices, showed transitory shifting shadows in the lung fields which were variable and fugitive. At the same time blood studies revealed a pronounced eosinophilia with fluctuations from 20-56 per cent, together with varying degrees of leukocytosis and increased sedimentation rate. At no time did the clinical picture correspond with the severity suggested by these findings. There was some correlation between the degree of eosinophilia and the roentgenological appearance but this was not precisely concurrent. At times some focal moist rales corresponded to the site of new shadows.

The course and progress of his disease during this hospital period is summarized in Table 1.

After discharge from the hospital, February 21, 1941, he was followed closely at home until

able to resume attendance at the Allergy Clinic. In addition to symptomatic therapy, treatment consisted of regular vaccine administration. It will be noted that in October and November, 1941, no influenza bacilli but pneumococcus type IV was found in the sputum.

In December, 1941, after re-administration of sulfathiazol he showed a marked conjunctival reaction to the drug.

His progress from February, 1941 to September, 1942, is summarized in Table II. During this period, with certain vicissitudes, there was fairly steady improvement. No roentgenographic changes were observed subsequent to May, 1942.

Table III summarizes the course of the patient's disease from September, 1942, until the present time (February, 1946). Readmission to the hospital in October, 1942, was necessitated by a severe attack of rheumatic purpura. Changes were then shown in the electrocardiogram, which were taken to be a further manifestation of vascular allergy.

#### COMMENT

The subject under discussion is one which should be of special interest to clinicians and roentgenologists as well as to those interested in allergy. As will have appeared evident, the most likely explanation of this condition lies along allergic lines. Löffler's own view that these transitory lung shadows are analogous to erythema nodosum, and therefore an allergic manifestation of an infective agent, not itself present in the "microbid" lesion, appeals to us as the most plausible hypothesis. Undoubtedly many of the reported cases have occurred in tuberculous individuals, and in these the lung shadows may be conceived of as "tuberculids." Our own case, while undoubtedly exhibiting roentgenologic evidence of old healed pulmonary tuberculosis, confirmed by a strongly positive Mantoux reaction, never at any time showed acid fast bacilli in the sputum, whether in concentrate smear or culture. The case did, however, consistently show in the sputum and in the infected sinuses *Haemophilus influenzae*, and with specific vaccine therapy, definite improvement followed.

The patient was, as so many of these cases are, an allergic subject, having suffered in his early youth from allergic rhinitis due in all probability to exposure to factory dust. When he came to our attention, he was suffering from ragweed pollen asthma, with superadded bronchitis and bronchorrhea. Specific vaccine therapy, followed by desensitization with ragweed pollen extract and house dust, was the chief remedial measure employed, and the success of these measures would indicate that the predictions were in large measure correct.

Certainly *H. influenzae* disappeared from the sputum for a period of many months and, coincidentally, the sputum became reduced from 400-500 cc. per day to practically none, or at least only what could be accounted for by residual upper respiratory infection and postnasal catarrh. At the same time the patient gained 40 pounds in weight and was able to return to employment.

With an exacerbation however, in the fall of 1942, following comparative comfort during the ragweed pollen season, *H. influenzae* again appeared in the sputum. Almost immediately after starting a fresh vaccine of this organism, the patient developed Schönlein's purpura as described, and coincidentally electrocardiographic evidence of bundle branch lesion, with subsequent normal tracings. This must be conceived, as Harkavy has recently pointed out, as incontrovertible evidence of vascular allergy; and by the same token, the transitory Löffler shadows seen in the lung may with propriety be regarded as allergic edema involving the capillary network of the interalveolar tissues of the lung. In addition, the intense bronchorrhea, with evidence of blood at times, probably indicated that capillary dilatation and edema of the bronchial mucosa was a preponderant mechanism, though spasm of smooth muscle was also evidenced in asthmatic attacks.

Exactly what conclusions one is justified in drawing in regard to the early diagnosis of bronchiectasis, when there was hemo-

TABLE I

Date	Leukocyte Count and Sedimentation Rate 1 hr.	Eosinophiles per cent	Roentgen Changes	Remarks
Nov. 18, 1940			Old tuberculous scars in each apex with calcification; diffuse patchy parenchymatous infiltrations each axilla, right mid-lung field and parahilar (Fig. 1, <i>a</i> and <i>b</i> )	Admitted Nov. 17 from Allergy Clinic; much cough and mucopurulent sputum—signs of asthmatic bronchitis
Nov. 19, 1940	21,000	14		No eosinophiles seen in sputum; asthmatic rhonchi throughout, with some moist rales left base posteriorly and right lung anteriorly
Nov. 27, 1940	29,100		More extensive and confluent in right mid-lung field, fading in the left axillary zone (Fig. 2 <i>a</i> )	Low grade irregular fever, maximum 101° F. since admission; sputum 200–400 cc. No acid fast bacilli, heavy growth of <i>Haemophilus influenzae</i> . Bronchoscopic Nov. 29 same; large quantity of yellowish nonfetid pus in right and left main and lower bronchi, congested and bled slightly; no granulations and no stenosis—"bilateral bronchiectasis"
Dec. 6, 1940	28,000 30 mm.	47	Fading in right mid-lung but exacerbation and extension along right axillary field. Further regression of the infiltrations in left lung (Fig. 2 <i>b</i> )	Cough severe, sputum 400–500 cc., often blood-streaked; rales and rhonchi cleared considerably
Dec. 10, 1940				Intermittent fever Nov. 30–Dec. 6 to 100.8° F., then continued fever Dec. 6–11, maximum 103° F.; lysis Dec. 13 after sulfathiazol commenced Dec. 10. Antra irrigated, return cloudy
Dec. 18, 1940	15,000	20	Both lung fields almost clear of the patchy changes (Fig. 2 <i>c</i> )	Afebrile period Dec. 13–18, recrudescence of fever Dec. 19–27, maximum 101.6° F. while still on sulfathiazol (reduced dosage). Signs in lungs largely disappeared, sputum 500 cc.
Jan. 7, 1941	33,000	56	Left lung virtually clear of all but old scars. New parenchymatous zone of infiltration right 1st and 2nd interspace, anteriorly (Fig. 2 <i>d</i> ).	Afebrile Dec. 27–Jan. 4, when slight (99.6° F.) fever; complains epigastric pain, barium series negative. Harsh breath sounds right axilla; few eosinophiles in sputum
Jan. 14, 1941	32,000	54		Slight fever to 99.4° F. Jan. 14–17; sputum 100–300 cc., cough easier, complains chiefly of epigastric discomfort 2 hr. p.c.
Jan. 20, 1941				Sputum increased: 300–400 cc.; not so well; irregular daily fever to 100.6° F. and 100° F. Jan. 17–30, one spike Jan. 18 to 103° F. Neosalvarsan tried without benefit
Feb. 3, 1941	16,800 38 mm.	40	Diffuse involvement of right axillary and apical lung field with return of a patchy zone at lower end of chief interlobar fissure which had not been seen since Nov. 27, 1940. Patchy area in left upper axillary lung field, which had not been previously involved (Fig. 3 <i>a</i> )	Bronchoscopic Jan. 28—Heavy growth <i>H. influenzae</i> only; autogenous vaccine commenced Feb. 6 (Kocto)
Feb. 17, 1941	(Bone marrow) 54,000	32		Afebrile Feb. 3–21 except Feb. 6 and 7; up and about ward convalescent. Marked loss of weight, 180–140 lb. O.T. 0.1 mg. positive. Retest with extrinsic allergens with again marked reactions to house dust, feathers, ragweeds, pyrethrum, and one plus to orris, tobacco and cattle hair
Feb. 21, 1941				Discharged to his home

TABLE II

Date	Leukocyte Count and Sedimentation Rate 1 hr.	Eosinophiles per cent	Roentgen Changes	Remarks
March 7, 1941	30,000	45	Subtotal regression of involvement right lung, leaving some interlobar pleural accentuation, some suggestion of reduction of volume right upper lobe—pectoral segment; increase in density of left apical lung field above and about area of Feb. 3 (Fig. 3 <i>b</i> )	Slight fever, stomach symptoms persist Occult blood in stool. Finally relieved with phenobarbital and atropine. Lungs clear on physical. Postnasal catarrh
April 9, 1941	24,000	27	Right side cleared save for diffuse increase in density pectoral segment of upper lobe, sharply demarcated by the pleural margin. Left apex clearing (Fig. 3 <i>c</i> ).	Slight cough and sputum. Gained 3 lb.
May 5, 1941	26,000	18		Nose trouble bad, cough and sputum much reduced. Occasional slight fever to 100° F.
May 14, 1941			Both lungs almost completely cleared—some residuum in right pectoral area	Has gained 11 lb. weight
June 10, 1941	43,000	37	Virtually all clear (Fig. 4 <i>a</i> )	Ragweed desensitization started May 23; insistence on attention to allergic factors. Few increased symptoms for 10 days—physical findings not striking
July 16, 1941	24,000 41 mm.	26		Vaccine therapy ( <i>H. influenzae</i> ) concluded. Moist rales right base
July 21, 1941				Recent exacerbation of cough and sputum, some blood staining. Histamine desensitization started July 29. Ragweed treatment continued
Aug. 26, 1941	22,000 35 mm.	23	All clear (Fig. 4 <i>b</i> )	
Oct. 3, 1941	25,000 40 mm.	39	Recurrence of patchy infiltrations diffusely throughout right upper lobe and considerable recurrence in left upper axillary lung zone (Fig. 4 <i>c</i> )	Some asthma and a little hay fever during ragweed season—still gaining weight (162 lb.)
Oct. 21, 1941	18,000 43 mm.	22	Clearing both sides—left more than right (Fig. 4 <i>d</i> )	Autogenous pneumococcus type IV vaccine commenced. No <i>H. influenzae</i> in sputum
Nov. 27, 1941	18,400 36 mm.	25	(25/11) Some exacerbation on right side	Clinical exacerbation, bacteriologic findings unchanged. Congested feeling in chest, blood streaked sputum, sneezing and rhinorrhea. Medium coarse rales right infraclavicular fossa, corresponding to fresh infiltration
Dec. 16, 1941		58	Slight recurrence left upper axilla. Right lung cleared further (Fig. 5 <i>a</i> )	No asthma, but other symptoms persist, temp. 100° F. Drug allergy to sulfathiazol in conjunctiva; cleared and reappeared on stopping and resumption. Signs at right apex cleared
Jan. 13, 1942	6,200	23	Marked clearing—trace in left axillary zone	Improvement with pneumococcus vaccine and caffeine iodide (eupnogene). Sputum reduced, more mucoid. Nose still troublesome
Feb. 6, 1942	11,400 28 mm.	17		Nasal mucous membrane pale, mucopus in middle meati—several polypi. Daily antral irrigations till clear Feb. 20. Ragweed (perennial) and autogenous house dust desensitization

TABLE II—Continued

Date	Leukocyte Count and Sedimentation Rate 1 hr.	Eosinophiles per cent	Roentgen Changes	Remarks
March 3, 1942	20,500 37 mm.	23	All clear (save for old scars) (Fig. 5 <i>b</i> ) and has remained so through repeated examinations (including the last one of February, 1946). At no time has there been any evidence of reactivation of his old tuberculosis	Chest symptoms much less
March 31, 1942	14,400 25 mm.	10		Chest good, nose trouble persists. Tuberculin (O.T.) 0.1 mg. 4 plus reaction with fever to 101° F. for two days
April 10, 1942				Nasal polypectomy—antral irrigation and solu-septasine instillation
May 12, 1942	14,000 25 mm.	13		Weight 170 lb. (gain of 30 lb.) Roentgen therapy to nose for persistent polyposis April 21–May 22 (twice weekly)
June 19, 1942	13,200 4 mm.	6		Improved
Sept. 4, 1942	16,000	14		Working steadily as taxi driver since July 6. Weight 180 lb. (normal). Ragweed and house dust continued

TABLE III

Date	Leukocyte Count and Sedimentation Rate 1 hr.	Eosinophiles per cent	Roentgen Changes	Remarks
Oct. 20, 1942	34,000 35 mm.	47	No change	A cold or hay fever early Sept. with some return of slight cough and greenish sputum, but no asthma. Sputum culture Sept. 26 again yielded heavy growth of <i>H. influenzae</i> ; new vaccine prepared and started Oct. 2. Oct. 9 came complaining of muscle and joint pains; subungual splinter hemorrhages noted Oct. 20
Oct. 23, 1942	30,000	45	No change (Oct. 26)	Hospitalized Oct. 23–Nov. 28. Fever to 100° F. for ten days, one spike to 101° F. Marked purpura, severe muscle and joint pains, spleen became palpable; muscle biopsy negative for trichiniasis and periarteritis nodosa
Oct. 28, 1942	(Bone marrow) 60,000 No eosinophilic myelocytes	46		Right bundle branch lesion in electrocardiogram on Oct. 24 and Nov. 5. Blood culture neg. Diagnosis, Schönlein's Purpura (anaphylactic), due probably to bacterial allergy, as it directly followed reinoculation with <i>H. influenzae</i> vaccine
Nov. 12, 1942	20,000 37 mm.	48		
Nov. 26, 1942	14,100 49 mm.	45	No change	Further vaccine therapy not advised. During this time, no cough or sputum
Jan. 22, 1943	11,200 32 mm.	10	No change	Some palpitation; no sign of bundle branch block, but some extra systoles in electrocardiogram. Feels very well
April 19, 1943	10,200 16 mm.	9	No change since May 1942 (Fig. 5 <i>c</i> )	Because of further nose trouble, roentgen therapy (3 treatments per week, total 1,350 r) Jan. 29–Feb. 17, with excellent result

TABLE III—Continued

Date	Leukocyte Count and Sedimentation Rate 1 hr.	Eosinophiles per cent	Roentgen Changes	Remarks
May 20, 1943				Resumed work as taxi driver; nose and chest symptoms negligible
Nov. 1, 1943	15,000 32 mm.	31	No change	Has been fairly well all summer on ragweed and autogenous house dust desensitization; very slight ragweed symptoms. Upper respiratory infection with cough and sputum end of September. Some mild muscle and joint pains with stiffness and tiredness mid-October; two or three small subungual splinter hemorrhages, but otherwise examination completely negative
Nov. 26, 1943			No change	Caught cold, fever to 101° F., cough and sputum, signs of bronchitis; sputum culture—heavy growth of mixed usual flora only
Feb. 22, 1944			No change (Fig. 5d). An essentially healthy chest. No reactivation of the old tuberculosis	Recent cold and some evidence of bronchitis
March 28, 1944			Roentgenogram of sinuses only	Roentgenogram shows extensive infection of left frontal sinus, both ethmoids and sphenoids. Dr. McNally on March 14 found evidence of extensive infection in sinuses; pus washed from antra grew <i>Neisseria catarrhalis</i>
June 13, 1944	10,200 33 mm.	10	No change (June 6)	Started on repeated small intracutaneous doses of stock vaccine; ephedrin 1% in saline Proetz and Parkinson positions with benefit
Feb. 2, 1945	12,700 41 mm.	4	No change	Has got along quite well except for postnasal discharge, with occasional slight exacerbations of cough and sputum; has kept at work fairly steadily; weight 174 lb. His persisting sinus infection is the problem; further roentgen therapy considered but withheld
Dec. 14, 1945			No change	Some coughing—few transitory rales
Jan. 22, 1946				Had epidemic influenza early January, but now back at work. No physical signs. Sputum culture; normal flora only
Feb. 6, 1946	8,000 28 mm.	8	Continues unchanged from appearance shown in Figure 5d	Continues at work but finds weather changes difficult

ptysis, and at a later period, duodenal ulcer with hematemesis, cannot be categorically stated. But it may be permitted to question whether these other conditions might not also have been manifestations of vascular allergy.

The importance of diagnosis must be apparent to all, and the ease with which it is possible to fall into error. Certainly any single roentgenogram, as may be seen from those illustrated, would be sufficient to stamp this as a case of tuberculosis. It is only when several roentgenograms are inspected, and this is correlated with the pronounced and shifting eosinophilia, that a correct diagnosis is possible.

It may be argued that our case showed many features which were atypical of Löffler's syndrome. Certainly there was considerable fever for several weeks, during which period there were large amounts of sputum, leukocytosis and high sedimentation rate as definite manifestations of the pulmonary infection. But these features are not entirely unusual and have been exemplified in other reported cases as indications of an associated infection.\*

\* Attention must be called to recent autopsy reports on cases of Löffler's syndrome appearing since this report was written, notably those by von Meyenburg,<sup>12</sup> and by Bayley, Lindberg and Baggenstoss,<sup>14</sup> and more recently by Bergstrand.<sup>15</sup> The findings vary from a pneumonic exudate in which eosinophilic leukocytes predominate to focal granulomatous lesions in which fibrinoid swell-

## SUMMARY

(1) A case is described, in some detail, of transitory shifting lung shadows associated with pronounced fluctuating blood eosinophilia (Löffler's syndrome) in an allergic individual.

(2) The patient's personal and family history bear evidence to his allergic predisposition.

(3) In addition to house dust and ragweed pollen, the patient also exhibited evidence of bacterial allergy to the infecting organism—namely, *Haemophilus influenzae*—a constant finding in sputum and infected sinuses.

(4) At a later period, on re-administration of the specific vaccine he developed joint and muscle pains, fever, and marked purpura of the Schönlein type, and during this episode, transitory bundle branch lesion was revealed by the electrocardiogram.

(5) This indisputable evidence of vascular allergy is corroborative of the view that the Löffler shadows are due to allergic edema of the interalveolar pulmonary tissue with its widespread capillary connections.

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ing and necrosis of collagen occur and at times vascular lesions corresponding to periarteritis nodosa. At any rate, the indications are that these transitory lung shadows may not always be transitory and may indeed progress to permanent organization. The paper by Bergstrand is of great interest and highly significant in this connection.

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# PULMONARY INFILTRATIONS ON ROUTINE CHEST ROENTGENOGRAMS\*

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NUMEROUS chest roentgen surveys have been made in recent years. The incidence of pulmonary infiltration on routine chest roentgenograms has been the primary aim of most observers. Little mention is made of the final diagnosis of these patients. The present report describes the findings and final diagnosis of 20 male soldiers, whose routine chest roentgenograms revealed pulmonary infiltration and who were carefully followed for from ten to twenty weeks in the hospital.

## INCIDENCE OF PULMONARY INFILTRATION ON ROUTINE CHEST ROENTGENOGRAMS

Hodges<sup>8</sup> found that 9.3 per cent of chest roentgenograms revealed abnormal findings, and that 1.5 per cent of routine films revealed evidence of pulmonary tuberculosis. Childress *et al.*<sup>4</sup> state that 2.8 per cent of patients surveyed by chest roentgenograms have reinfection type tuberculosis. Zacks and Hyde<sup>11</sup> noted that of 160 "pulmonary suspects" on roentgen examination 86 (54 per cent) had pulmonary tuberculosis. The remainder had either normal chests, healed primary tuberculosis, or non-tuberculous pulmonary disease, such as bronchiectasis, silicosis, sarcoidosis, fibrosis, or pulmonary abscess. Block and Tucker<sup>3</sup> found that 1.3 per cent of white patients and 2.6 per cent of colored patients yielded evidence of active pulmonary tuberculosis on routine chest roentgenograms. Seymour<sup>10</sup> found that of 100,000 selectees roentgenographed, 2.4 per cent had pulmonary lesions. Two per cent of the 100,000 had pulmonary tuberculosis. Duncan and McKinley<sup>5</sup> report a survey based on 6,400 chest roentgenograms. This disclosed 1.4 per cent of

individuals to have tuberculosis and 1.3 per cent to be "suspected cases of tuberculosis." No statement is made concerning the final diagnosis of these tuberculous suspects. Alpern and Benjamin<sup>1</sup> report 23 patients who were admitted for study solely on the basis of a routine chest film; 11 were proved to have active pulmonary tuberculosis. Gould<sup>6</sup> reporting on 20,350 routine chest roentgenograms found that 4.9 per cent were reinfection tuberculosis, 1.3 per cent were suspicious of tuberculosis, and 0.6 per cent were characterized by pulmonary fibrosis. Hilleboe and Morgan<sup>7</sup> state that of more than 1,000,000 chest roentgenograms of employees in the United States, 1.5 per cent gave roentgen evidence of reinfection pulmonary tuberculosis. Schiller<sup>9</sup> found that 2.12 per cent of 40,283 selectees were rejected because of pulmonary lesions.

## PRESENT STUDY

Each of the 20 patients of this report was sent to this hospital for thorough study after a routine chest roentgenogram taken as part of the separation process from the Army revealed a pulmonary infiltration. The transfer diagnosis of each patient was "Observation for tuberculosis." Workup included careful history, physical examination, usual laboratory studies, sputum and gastric examinations for acid-fast bacilli, serial sedimentation rates, serial chest roentgenograms, comparison of the present films with patient's induction chest roentgenogram, temperature, pulse, and respiration determinations four times daily, and tuberculin and coccidioidin skin tests. The results can be seen in Table 1.

\* From the McCornack General Hospital, Pasadena, California, and Bellevue Hospital, New York, New York.



## SUMMARY OF CLINICAL FINDINGS

Case	Age	Family History for Tuberculosis	Induction Chest Roentgenogram	Present Roentgen Findings	Skin Test		Sputa and Gastrics for Acid-Fast Bacilli	Highest Sed. Rate (mm.)	Highest Leukocyte Count (X1,000)	Period of Observation (wk.)	History						Comment	
					Cocc.*	TBC† 1st 2d					Cough	Sputum	Hemoptysis	Wt. Loss	Pleurisy	Chest Ache		Fever
1	W.C.S.	22	-	Neg. 1943	Left apical infiltration	-	+	8 neg.; then pos. sputa	2	12	11	+	+	-	-	-	+	Rales at left apex
2	D.V.	25	-	Neg. 1943	Left apical	-	+	8 neg.	20	12		+	-	-	-	+	+	Developed pleural effusion
3	A.C.	18	-	Neg. 1944	Right upper lobe small cavity	-	+	10 neg. then pos. gastrics	9	14	10	+	+	-	+	-	-	Positive gastrics after 2 mo.
4	H.F.	23	-	Neg. 1942	Left upper lobe infiltration	-	+	18 neg. then pos. gastrics	25	7	11	+	+	-	-	-	-	Sedimentation rate up 3 mo. Pos. gastrics after 3 mo. observation
5	W.O.R.	21	-	Neg. 1943	Right upper lobe density	-	+	18 neg.	20	6	12	+	+	-	-	-	-	10 lb. wt. loss in 1 yr. Regained in hospital
6	G.N.	25	+	Neg. 1943	Right upper lobe infiltration	-	+	16 neg.	18	8	14	+	+	-	+	-	-	2 sisters have pulmonary tuberculosis
7	J.O.	21	+	Neg. 1943	Bilateral apical infiltrations	-	+	18 neg.	9	9	10	-	-	-	-	-	-	Sedimentation rate elevated 3 mo. Told he had "spot" at left apex in Jan., 1944
8	P.M.	38	-	Neg. 1943	Right upper lobe lesion	-	+	14 neg.	24	6	12	-	-	-	-	-	-	"Scrofula" at age 10 yr.
9	J.S.M.	28	+	Neg. 1942	Bilateral apical infiltrations	-	+	10 gastric cultures negative	23	5	20	-	-	-	-	-	-	Father, mother, grandfather have tuberculosis
10	C.B.	21	-	Neg. 1943	Left upper lobe lesion	-	+	16 neg. sputa and 2 neg. cultures	37	8	18	+	+	-	-	-	+	Pleural effusion Feb., 1945 in Japanese prison
11	G.B.E.	32	-	Pos. pleural "scar"	Right upper lobe apical thickening	-	+	6 neg.	32	7	20	-	-	-	-	-	-	Transferred
12	E.S.	25	+	Pos.	Left upper lobe lesion	-	+	16 neg.	19	8	10	-	-	-	+	-	-	Sedimentation rate elevated 3 mo.
13	A.J.L.	26	-	Neg. 1941, 1945	Left upper lobe infiltration	-	+	17 neg.	12	5	12	-	-	-	-	+	-	Pleurisy in 1941 and 1942
14	Y.L.	20	-	Neg. 1943	Bilateral infiltrations	-	+	15 neg.	38	6	4	-	-	-	-	-	-	Joint aches; "flu" 1 mo. before admission
15	A.J.	31	-	Neg. 1943	Left upper lobe infiltrations	-	+	17 neg. 3 neg. cultures	37	8	20	+	+	-	-	-	-	
16	F.J.	24	-	Neg. 1943	Right upper lobe infiltrations	+	+	6 neg. gastrics	7	5	10	-	-	-	-	-	-	
17	C.N.F.	33	+	Pos. 1944	Bilateral apical infiltrations	+	-	14 neg.	22	7	8	+	-	-	-	-	-	
18	M.T.	21	-	Neg. 1943	Left upper lobe infiltrations	+	+	12 neg.	23	6	10	-	-	-	-	-	-	
19	E.S.	33	-	Neg. 1942, 1945	Right upper lobe infiltrations	+	-	16 neg.	55	8	10	-	-	-	-	-	-	
20	G.R.W.	31	-	Neg. 1943	Left upper lobe infiltrations	-	-	12 neg.	4	7	8	-	-	-	-	-	-	

\* Coccidioidin (1:150)  
† Tuberculin

\* Coccidioidin (1:50)

† Tuberculin 1st and 2d strength, Purified Protein Derivative

Of the 20 patients, 15 (75 per cent) had pulmonary tuberculosis, 4 had coccidioidomycosis, and in 1 patient no definite diagnosis could be made.

Of the 15 patients with pulmonary tuberculosis, 4 had active tuberculosis and 9 cases were believed to be arrested. In 2 patients activity could not be determined definitely during the period of observation. Considering the 4 cases of active pulmonary tuberculosis, several interesting facts should be mentioned. Case 1 had a normal sedimentation rate and no change on serial chest roentgenograms. After repeated negative sputum examinations and eight weeks of observation with normal temperature and pulse rates, specimens of sputum positive for acid-fast bacilli were secured. Case 2 had a slightly elevated sedimentation rate and leukocytosis. After eight specimens of sputum negative for acid-fast bacilli and five weeks of observation, the patient developed a pleural effusion. Case 3 had a thin-walled, small cavity of the upper lobe without any surrounding reaction, so often seen in coccidioidomycosis. The patient had lived in the San Joaquin Valley for many years, but his coccidioidin skin test was negative. The sedimentation rate was elevated and the white blood count was 14,000 per cubic millimeter. The patient was treated with strict bed rest. Repeated sputum and gastric examinations were negative for acid-fast bacilli until the ninth week of observation when the first of several gastric washings positive for acid-fast bacilli was secured. Case 4 had a persistently slightly elevated sedimentation rate. After 18 negative sputum and gastric examinations and ten weeks of bed rest, positive gastric washings for acid-fast bacilli were obtained. The importance of *continued* observation and *repeated* sputum and gastric examinations for acid-fast bacilli is evident.

Nine patients who were followed from ten to twenty weeks in the hospital were judged to be cases of arrested pulmonary tuberculosis. These patients were asymptomatic, except for slight cough in several, and had negative physical examinations.

They were afebrile, had no changes on serial chest roentgenograms, and had positive tuberculin and negative coccidioidin skin tests. Their sedimentation rates were occasionally elevated slightly on admission, but these soon dropped to normal, usually within one to two weeks. The cause of these occasional elevated sedimentation rates was not clear.

In 2 cases no definite decision could be made concerning activity. Case 14 was asymptomatic, afebrile, and negative to physical examination. However, he was observed for only four weeks. During this time he had 15 specimens of sputum which were negative for acid-fast bacilli, but his sedimentation rate remained elevated. He was transferred to a hospital closer to his home for further observation. Case 15 has been followed for sixteen weeks. He has had 26 negative sputum and gastric examinations for acid-fast bacilli, but his sedimentation rate has remained elevated. He has a slight chronic cough, and physical examination reveals a few fine rales at the left apex. He has been afebrile, and serial chest roentgenograms have shown no change.

Cases 16, 17, 18 and 19 were found to have coccidioidomycosis. Each gave a history of having lived in a known endemic area of this disease. Each had a positive coccidioidin skin test (1:50 dilution). Cases 16 and 18 had positive tuberculin skin tests also, but Cases 17 and 19 had negative tuberculin skin tests. These 4 patients had no active disease.

Case 20 had a right apical infiltration detected on a routine chest film. He was asymptomatic, and had negative physical examinations, no changes on serial chest roentgenograms, normal sedimentation rates, sputum negative for acid-fast bacilli, and negative tuberculin and coccidioidin skin tests. No histoplasmin was available for skin testing. The etiology of the pulmonary infiltration of this patient could not be determined.

The incidence (20 per cent) of coccidioidomycosis in this small series of cases may seem unduly high. However, it must be

recalled that large numbers of soldiers from all parts of the country were stationed and trained in areas of California, New Mexico, Arizona and western Texas which are now known to be endemic foci of coccidioidomycosis. Physicians everywhere must expect to see more cases of coccidioidomycosis. The use of the simple coccidioidin skin test will increase, and will aid greatly in the detection of this disease. It may be of interest to note, in passing, that 12 per cent of 269 soldiers in Los Angeles had positive coccidioidin skin tests and 73 per cent had positive tuberculin skin tests, using coccidioidin (1:50) and tuberculin Purified Protein Derivative (1st and 2nd strengths). Almost all of these men were in the age group of twenty to thirty-five years.

Each patient judged to have arrested pulmonary tuberculosis was advised to have a monthly chest roentgenogram for six months, and less frequent but continued observation after the six month period. Since the induction chest roentgenograms had been negative in nearly all cases, all of these patients must have had recent pulmonary infiltrations. The importance of careful, continued observation must be emphasized. Amberson<sup>2</sup> has stressed the potential lability of minimal tuberculous pulmonary infiltrations in young adults.

#### SUMMARY AND CONCLUSION

1. Observers reporting on routine chest roentgen surveys note that from 2.1 to 9.3 per cent of roentgenograms reveal abnormal findings, and that 1.3 to 4.9 per cent of all chest films disclose evidence of reinfection pulmonary tuberculosis.

2. Twenty soldiers whose routine chest roentgenograms revealed pulmonary infiltrations were carefully studied for from ten to twenty weeks. Of this group (a) 4 patients (20 per cent) were found to have active pulmonary tuberculosis; (b) 9 patients (45 per cent) were found to have arrested pulmonary tuberculosis; (c) 2 patients had pulmonary tuberculosis but activity could not be definitely determined during their periods of observation; and (d)

4 patients (20 per cent) were found to have healed, old coccidioidomycosis with stable pulmonary lesions. The cause of one patient's pulmonary infiltration could not be ascertained.

3. The importance of continued observation, repeated sputum and gastric examinations for acid-fast bacilli, serial chest roentgenograms, and weekly sedimentation rates, as aids in determining the activity of pulmonary lesions, is stressed.

4. Many soldiers have had coccidioidomycosis as a result of training in endemic areas of the United States. These men will return to their homes and a certain number will bear residua, such as pulmonary fibrotic areas and infiltration. Differentiation from tuberculous infiltrations may be difficult.

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# ROENTGEN DEMONSTRATION OF CALCIFICATIONS IN THE INTERVENTRICULAR SEPTUM IN CASES OF HEART BLOCK\*

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**D**URING the last few years, we have had the opportunity to study roentgenologically 61 patients showing calcifications in the mitral annulus fibrosus, in the aortic ring, or in their valves. Twelve of these patients suffered from heart block. Since it is known that in such conditions calcifications may extend into the membranaceous septum and may interrupt the conduction pathway,<sup>1,6,7,11,12,14,27</sup> our attention has been directed to establishing roentgen signs of calcifications in the membranaceous septum.

Calcific deposits of the rings and of the valves are well evaluated from pathological,<sup>5,6,7,10,12,13,14,24</sup> roentgenological,<sup>4,8,13,15,16,18,21,22,24,26</sup> and clinical<sup>1,2,3,6,8,10,17,27</sup> viewpoints. The pathological aspects of their extensions into the septum and associated disturbances of conduction have been repeatedly described.<sup>1,6,7,12,14,19,27</sup> However, according to available information, no attempt has been made to identify septal calcifications in living persons.

Our studies were carried out by establishing the position of the membranaceous septum, in roentgenological projections of the heart and by evaluation of pathologico-anatomical data of septal calcifications. In 3 instances our roentgen findings in heart block were controlled in postmortem examinations. Finally roentgenological observations in 49 cases with annular and valvular calcifications and without heart block were compared with 12 similar cases having heart block.

## ANATOMY

The mitral annulus fibrosus is not a complete ring.<sup>7,20,23</sup> It is approximately horse-shoe-shaped and encircles the mitral ostium on three sides, being absent at the root

of the aorta. Its endings at either side merge into two nodular thickenings of dense fibrous tissue. These are the trigona fibrosa. The mitral ring is effectually completed by a system of fibers filling out the space between the trigones. These fibers are contributed by the opposing portions of the right (posterior) and of the left (anterior) trigonum fibrosum. They are reinforced by bundles of the aortic ring and by so-called fila coronaria. Fibers of the mitral annulus fibrosus do not enter this space.<sup>7,18</sup>

This explains why, in a large majority of cases, calcareous deposits in the mitral annulus fibrosus are C-, J-, or U-shaped.<sup>7,20,</sup> own observations It also explains that if a completely calcified ring is present around the mitral ostium, calcifications involve not only the annulus fibrosus, but also the fibrous trigones at either side and the space between the trigones as well.

The membranaceous septum lies anteriorly to the right (posterior) fibrous trigonum with which it is partly interwoven. The same trigonum also constitutes the end of the posterior branch of the mitral annulus fibrosus. Consequently, it is a connecting link between the annulus and the membranaceous septum. The crus commune of the bundle of His passes through the posterior portion of the same trigonum.

Close spatial proximity also exists between the membranaceous septum and the aortic ring. The septum is located below the right and the posterior semilunar valves of the aorta. Fibers of the septum thus extend craniad and anteriorly into the intervalvular space between the right and posterior valves and their Valsalvan sinuses. Here they merge into the aortic ring.

The collagenous fibers of the mitral,

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aortic, and tricuspid rings, together with the trigona fibrosa and the fila coronaria, represent an anatomical and nutritive entity, the "skeleton of the heart" (Herzskelett of Tandler).<sup>7,17,23</sup> In susceptibility to degenerative changes, it stands in con-

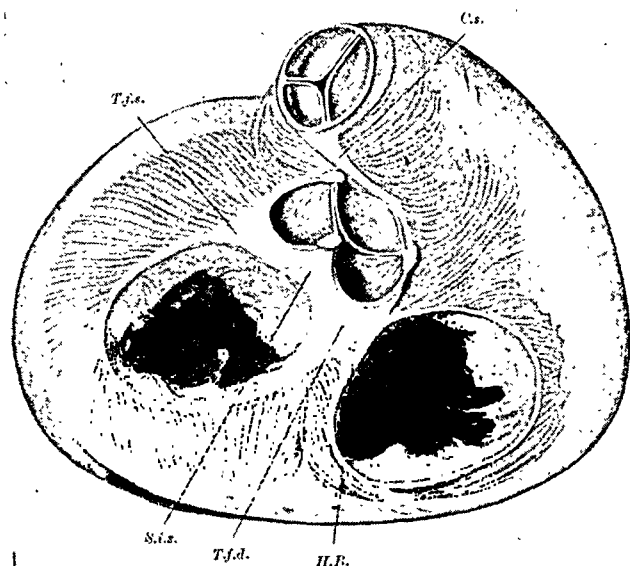


FIG. 1. Auricular view of fibrous skeleton of heart ("Herzskelett") and of relations of the atrioventricular ostia, of the aortic and pulmonary valves. (From Julius Tandler: *Lehrbuch der systemischen anatomie*. Vol. 3, Fig. 23, F. C. W. Vogel, Leipzig, 1926.)

*T.f.s.*, left fibrous trigonum; *T.f.d.*, right fibrous trigonum; *H.B.*, bundle of His; *C.s.*, tendon of pulmonic conus.

trast to the adjacent vascular or muscular tissue; however, calcifications in the tricuspid ring are extremely rare.

#### PATHOLOGY

Numerous papers<sup>5,6,7,10-14,24</sup>, on the pathology of calcifications of the mitral and aortic rings and of the septum may be summarized as follows:

1. Calcium deposits in the mitral annulus fibrosus, in the mitral and aortic valves, and in adjacent fibrous tissue are frequent. They occur in 7.5 to 8.7 per cent of all autopsies and in 20 per cent beyond the fifth decade. They are about three times as frequent in females as in males.

2. The deposits are usually first seen in the posterior third of the mitral ring with extensions toward the right trigonum and

the septum, and toward the lateral parts of the ring.

3. On the extension of the deposits to the right trigonum, there is division into two branches. One continues into the trigonum and the other into the posterior or lower portion of the septum membranaceum.

4. With heavier calcifications, there may be a continuation across the space between the right and left trigonum, in the opposing portions of the trigona themselves, and in adjacent bundles of the aortic ring and the fila coronaria. In such cases, calcifications form a complete ring about the mitral ostium or are crescent shaped.

5. Calcifications in the aortic area begin at the roots of the valves. Frequently they are associated with calcareous deposits in the insertion of the adjacent aortic leaflet of the mitral valve. Caudad extensions from the right semilunar valve as a rule involve the membranaceous septum.

6. Calcific deposits extending to the septum from the mitral annulus or the aorta are first located in the area of the bifurcation of the conduction bundle and

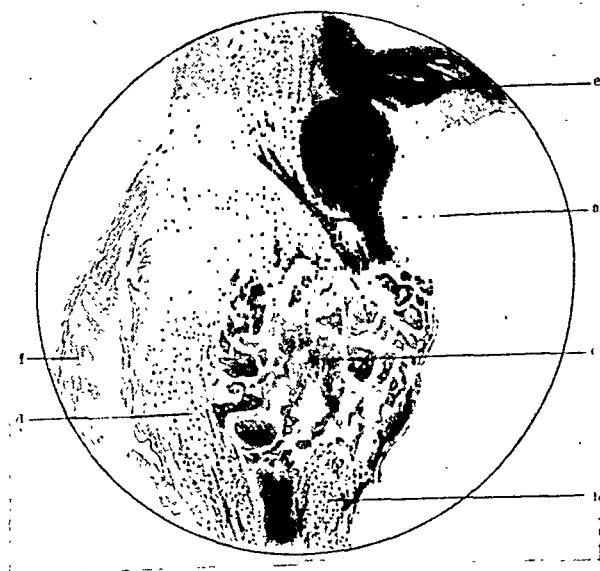


FIG. 2. Photomicrograph showing calcium deposits in the membranaceous septum, low power, Van Gieson stain. (After F. Mönckeberg: *Die Erkrankungen des Myokards und des spezifischen Muskelsystems*, Fig. 43, page 518.) *e*, medial leaflet of the bicuspidal valve; *a*, atrioventricular node; *c*, calcareous deposits in the membranaceous septum; *d*, interventricular muscular septum; *f*, medial leaflet of tricuspid valve.

later involve the area of the crus commune. The bundle itself is apparently more flexible than other parts of the septum. It first becomes displaced, then stretched, degenerated, and finally calcified.

7. Calcium deposits in the regions concerned are a part of degenerative changes. They are associated with or preceded by atheroma, necrobiosis, and fatty or hyaline degeneration, and occasionally with (senile) disturbances of calcium metabolism. In 3 of our cases Paget's disease was present.

8. In general, the changes are sometimes considered as being a disease entity involving primarily the fibrous structures (Herzskelett) of the heart ("annular sclerosis" of Dewitzky). No known relationship exists with generalized arteriosclerosis or syphilitic vascular disease. In one of our observations calcifications of the mitral annulus were associated with idiopathic medionecrosis of the aorta. The condition is

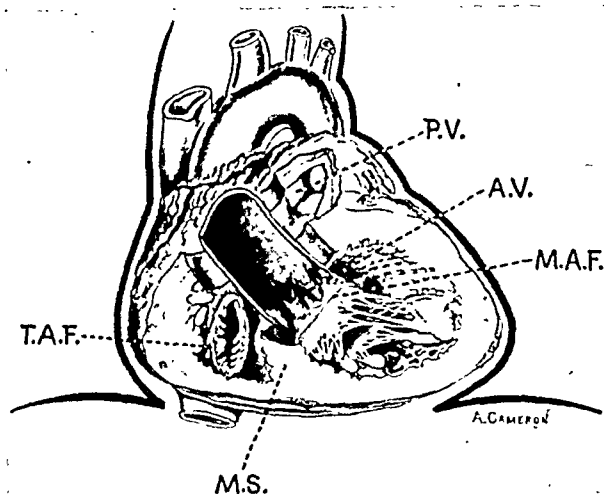


FIG. 3. Anterior view of the heart after removal of the anterior wall in coronal plane, showing projections of the mitral and tricuspid annulus fibrosus, of aortic and pulmonary valves. Partial use has been made of one of Testut's illustrations (Traité d'anatomie humaine. Vol. II, Part I, Paris, 1909.)

*M.A.F.*, mitral annulus fibrosus; *M.S.*, muscular septum; *T.A.F.*, tricuspid annulus fibrosus; *P.V.*, pulmonary valves; *A.V.*, aortic valves.



FIG. 4. *A*, roentgenogram of calcified circumflex branches of the coronary arteries and of calcified aortic valves. Ventricular view; left oblique 60°. Male, aged seventy-four, with angina pectoris. *B*, superimposed drawing on same roentgenogram shows positions of fibrous rings of mitral and tricuspid ostia and adjacent fibrous structures in left oblique view. 1, calcified aortic valves. 2, calcified left coronary artery, circumflex branch. 3, calcified right coronary artery, circumflex branch. 4, mitral annulus fibrosus, posterior fibrous trigonum. 5, left (anterior) fibrous trigonum. 6, mitral annulus fibrosus, posterior fibrous trigonum. 7, right (posterior) fibrous trigonum. 8, membranaceous septum. 9, bundle of His. 10, tricuspid annulus fibrosus.

TABLE I

Case No.	Records	History	Cardiac Findings	Electrocardiogram	Roentgen Findings	Pathology
I	T. S. 50 yr. Male. St. 221626	Tonsillitis, scarlet fever, rheumatic fever. Cardiac for 7 yr.	Calcareous aortic stenosis. Harsh systolic murmur, precordial. Aortic thrill. Diastolic murmur	A-V block	Heavy calcifications in aortic valves and aortic ring. Calcifications extend downward into area of membranaceous septum	Aortic valves completely rigid and calcified $1 \times 1.5$ cm. thick. Calcium deposits extend into mitral leaflet and into membranaceous septum
II	C.C.M. 74 yr. Male. Private service	Cardiac symptoms for 15 yr. No rheumatic fever	Dyspnea. Ankle edema. Cardiac enlargement. Blowing systolic murmur over aorta. Left hypetr.	Prolonged conduction time 0.28 sec.	Heavy aortic calcification involving all valves and extending into septum	Permission for autopsy refused
III	L.B. 72 yr. Female. S.F.H. D-256955	Hypertensive disease of long duration. No rheumatic fever	Dyspnea. Blood pressure 270/110. Congestive failure. Systolic thrill at base with loud murmur. Blowing diastolic murmur	Complete A-V block	Complete mitral ring calcification with extension toward septum and into intertrigonal space	Coronary arteriosclerosis. Extensive calcification of mitral annulus fibrosus (1 cm. thick) with extension well into posterior part of membranaceous septum. Myocardial infarction
IV	M.L. 79 yr. Female. Private service	Hypertensive disease of long duration. No rheumatic heart disease	Murmur for 20 yr. Blood pressure 200/90. Dyspnea. Moderate congestion. Coarse systolic and early diastolic murmur. Bradycardia	1939: Complete block. 1942: 2:1 block	Complete mitral ring calcification with more massive calcium deposits near posterior fibrous trigonum	Permission for autopsy refused
V	L.T. 72 yr. Female. A-90449	Syphilis. Stokes-Adams attacks. No rheumatic fever	Congestive heart failure with dyspnea. Edemas. Fairly loud, rough murmur, systolic at base	Mostly complete A-V block; occasionally, 2:1 block, varying with left bundle branch block	Incomplete calcification of mitral ring with larger deposits in posterior trigonum. Posterior half of intertrigonal space calcified	Complete calcification of annulus fibrosus from which several nodules encroached on membranaceous septum extending on other side of septum and also into tricuspidal valves
VI	R.J. 82 yr. Male. S.F. 81683	No rheumatic fever	Dyspnea. Ankle edema. Enlarged heart. Low pitched systolic murmur above aorta. Loud rumbling systolic apical murmur	Alternating A-V block. Left bundle branch block. Auricular fibrillation	Fluoroscopic only. Calcifications not specified	Calcifications on base of mitral valves extending into membranaceous and muscular septum in area of crus commune
VII	J.D. 75 yr. Female. S.F. 92278	In semicoma	No murmurs	Complete A-V block	Complete ring calcification of mitral annulus	Permission for autopsy refused
VIII	L.McC. 74 yr. Female. S.F. 85347	Diabetes mellitus. No rheumatic fever	Heart disease for 14 yr. Harsh precordial systolic murmur. Enlargement of heart	Left bundle branch block. Prolonged conduction time	Heavy ring calcification in mitral annulus fibrosus	Permission for autopsy refused

TABLE I—Continued

Case No.	Records	History	Cardiac Findings	Electrocardiogram	Roentgen Findings	Pathology
ix	R.D. 72 yr. Female. S.F. 81112	Paget's disease. No rheumatic fever	Cardiac enlargement. Systolic murmur over aorta	Complete A-V block	Calcifications looked for but not seen	Calcification of mitral annulus and aortic leaflet. Membranaceous septum calcified
x	Ph.B. 65 yr. Male. A-95563	No rheumatic fever. Cardiac for 10 yr.	Dyspnea. Angina pectoris. For many years systolic precordial murmur	3:2 block	Complete mitral ring calcification with nodular calcium deposits in area of septum	Permission for autopsy refused
xi	R.A. 83 yr. Female. S.F. 96434	Paget's disease. Shortness of breath for 6 yr.	Moderate leg edema. Cardiac congestion. Greatly enlarged heart. Later, heart size diminished. Loud precordial systolic murmur. Rumbling diastolic murmur	Complete A-V block. Left axis deviation	Complete calcification of mitral annulus fibrosus extending into surrounding of posterior trigonum	Still alive
xii	W.L. 74 yr. Male. S.F. 89372	Increasing weakness. Precordial pains. Shortness of breath	Decompensated cardiac congestive disease. Dyspnea. Bradycardia	Idioventricular rhythm with left bundle branch block	Complete mitral ring calcifications	Permission for autopsy refused

Clinical viewpoints in Cases iii, iv, v, x and xi of this table are described in detail by Rytand and Lipsitch in their recent paper.<sup>17</sup> (Refer to Cases 3, 1, 5, 2, and 4.)

said to be frequent in cows and dogs where, in addition to calcifications, bone and cartilage formation is often observed in the trigona and in the mitral annulus fibrosus.<sup>23</sup>

9. Calcifications on an inflammatory basis do not follow the patterns outlined above concerning occurrence, pathogenesis and extension.

10. Isolated calcifications of the septum membranaceum are rare and usually of microscopic size.

Cases of heart block observed and studied by us are summarized in Table i.

ROENTGEN IDENTIFICATION OF SEPTAL CALCIFICATIONS

The elaborated techniques of Sosman and his co-workers are referred to for general rules concerning roentgenological location and identification of endocardial calcifications.

In all of our cases of heart block, calcifications of the septum were associated with calcifications of the aortic or the mitral ring. The mitral ring was involved in 9 cases, the aortic valves in 3 cases. No calcified tricuspid ring was found in our studies.

The location of the septum was correlated to that of the adjacent calcified ring or valves by using postmortem specimens of cases studied roentgenologically during life.

In studying the relationship of the septum to the mitral and the aortic rings, the observations were made more precise by roentgenograms taken in typical projections from a heart specimen, in which the rings were marked with a wire loop, and the septum with a bit of wire fly-screen. We could thus demonstrate not only the spatial interrelationship of these structures, but also their overlapping and foreshortening in roentgenography and roentgenoscopy.

According to our anatomical studies—the results of which are consistent with those of other investigators—that part of the membranaceous septum containing the crus commune of the conducting bundle is immediately contiguous with the right



trigonum fibrosum. In order to find this point, roentgenoscopic examination was done. For mitral calcifications the left oblique diameter of the thorax was de-

trigonum was localized at the medial (right) end of the posterior branch of the calcified mitral ring. The posterior branch of the ring was projected on the wall of the

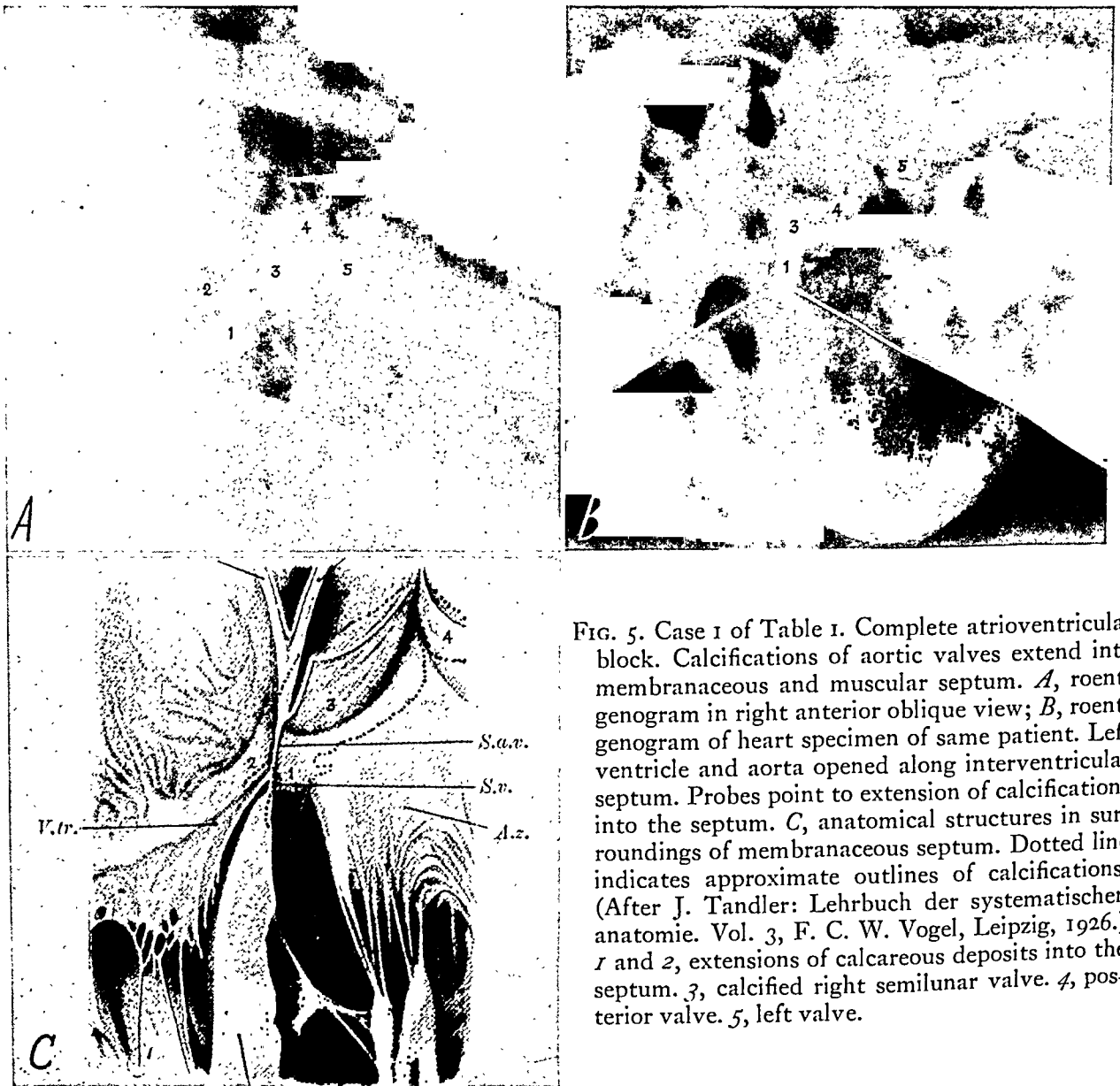


FIG. 5. Case 1 of Table 1. Complete atrioventricular block. Calcifications of aortic valves extend into membranaceous and muscular septum. *A*, roentgenogram in right anterior oblique view; *B*, roentgenogram of heart specimen of same patient. Left ventricle and aorta opened along interventricular septum. Probes point to extension of calcifications into the septum. *C*, anatomical structures in surroundings of membranaceous septum. Dotted line indicates approximate outlines of calcifications. (After J. Tandler: *Lehrbuch der systematischen anatomie*. Vol. 3, F. C. W. Vogel, Leipzig, 1926.) 1 and 2, extensions of calcareous deposits into the septum. 3, calcified right semilunar valve. 4, posterior valve. 5, left valve.

terminated, which showed the ring calcification in its most open and most clearly discernible degree. This was usually 60 degrees or a little more from the coronal plane. The patient was then marked on the skin at both ends of the diameter, as suggested by Sosman, for later roentgenograms. A similar procedure was carried out in the lesser right oblique position in which the calcification appears as a linear shadow. In this manner the area of the right (posterior)

thorax caudad to the anterior branch. If calcifications formed a regular circle, the trigona and the intertrigonal space were recognizable not only by their localization but also by the change of the morphology of calcifications. Calcium deposits in the intertrigonal space were more granular and not as homogeneous as they were in the annulus itself.

In cases of aortic calcifications the two oblique projections at about 20 degrees and

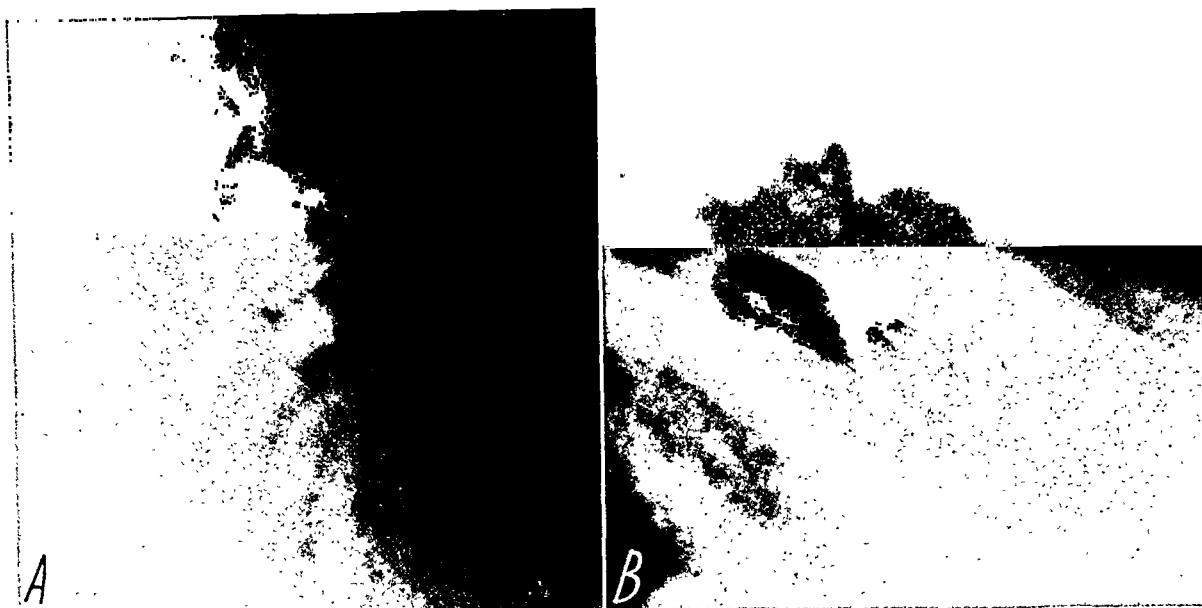


FIG. 6. Case II of Table I. Prolonged conduction time. Calcifications of aortic valves extend into membranous and muscular septum and in aortic leaflet of the mitral valve. *A*, right anterior oblique view; *B*, right lateral view.

the left oblique approaching a lateral were used. Because of the obliquity of the aortic ostium, it was sometimes helpful to lean the subject or to direct the roentgenographic tube away from the horizontal into the axis of the aortic root, to visualize the calcifications with less over-projection. In this area the deepest caudad extension of the calcium deposits from the semilunar valves

into the contiguous membranaceous or muscular septum was determined. In these studies roentgenoscopic parallax proved to be an indispensable adjunct.

In cases of heart block we observed with this technique three types of calcifications which we considered as being located in the membranaceous septum.

1. *Deep caudad extension of aortic calcium*



FIG. 7. Case III of Table I. Atrioventricular block. Complete mitral "ring" calcifications. *A*, roentgenogram in left oblique position; *B*, roentgenogram in right anterior oblique position. 1, area of right (posterior) fibrous trigonum. 2, extension of calcifications into the intertrigonal space. 3, area of left (anterior) fibrous trigonum. 4, extensions into the septum.

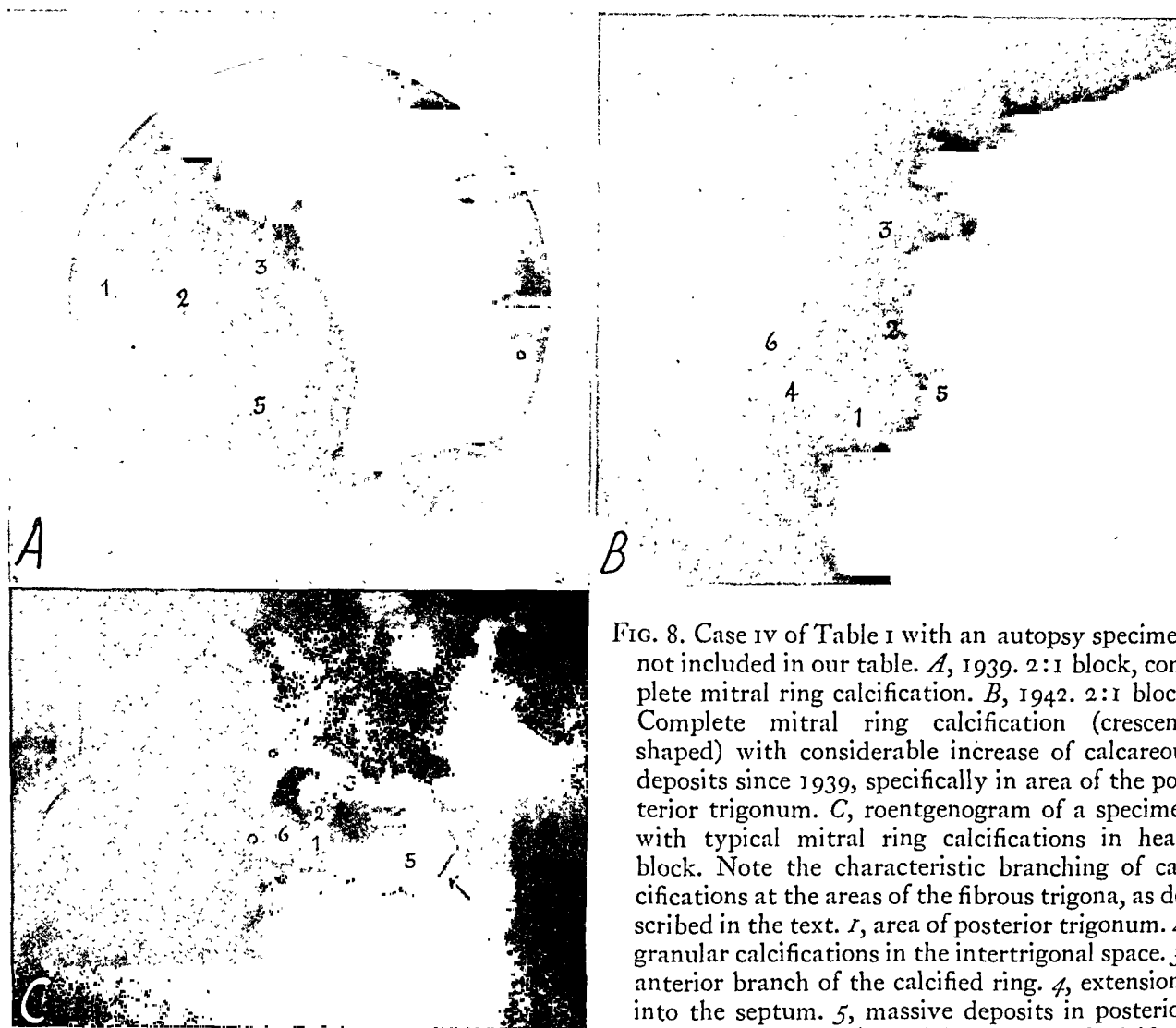


FIG. 8. Case IV of Table I with an autopsy specimen, not included in our table. *A*, 1939. 2:1 block, complete mitral ring calcification. *B*, 1942. 2:1 block. Complete mitral ring calcification (crescent-shaped) with considerable increase of calcareous deposits since 1939, specifically in area of the posterior trigonum. *C*, roentgenogram of a specimen with typical mitral ring calcifications in heart block. Note the characteristic branching of calcifications at the areas of the fibrous trigona, as described in the text. 1, area of posterior trigonum. 2, granular calcifications in the intertrigonal space. 3, anterior branch of the calcified ring. 4, extensions into the septum. 5, massive deposits in posterior branch of the ring. 6, medial extension of calcifications.

*deposits.* Such deposits primarily involve the junction of the semilunar valves with the aortic root. As a rule, caudad extensions occur after all three semilunar valves and their valsalvan sinuses have calcified.

Such extensions were found in 2 cases of septum calcifications associated with heart block. No such extension was recognizable in any of the cases in which no heart block or prolonged conduction was recorded.

2. *Complete ring calcifications at the mitral ostium.* As previously noted, the mitral annulus is horseshoe-shaped and encircles all except the anterosuperior quadrant of the ostium. This part is the space between the trigona fibrosa. The right trigonum carrying a portion of the bundle of His is seen at the right (medial) end of the pos-

terior branch of the mitral annulus. If a complete ring of calcification is formed then the right trigonum is involved.\*

Eight complete ring calcifications in 12

\* Complete "ring" calcifications represent often not circles but crescents. The intertrigonal calcifications are in such instances around a segment, the convexity of which points toward the lumen of the mitral ostium. This indicates that at times the root of the aorta bulges into the mitral ostium.

These findings are in contrast to anatomical descriptions of the mitral ostium which state that the ostium is ring shaped.

The bulging of the intertrigonal space (aortic root) into the mitral ostium is apparently not yet described because no intravital observations of physiological or pathologico-physiological conditions in this area have been made. In our cases the findings were persistent during several years of observations. Consequently they cannot represent a pulsatory phase of the root of the aorta. Since not all of our cases of mitral ring calcifications show the bulging of the calcified aortic root into the ostium, it is reasonable to believe that this phenomenon occurred in cases of pathological dilatations of the root of the aorta. The calculated radius of the bulging sector of the aorta indicated this clearly. In one of our cases the loss of the surface of the lumen of the mitral ostium through the bulging aortic sector exceeded 32 per cent.

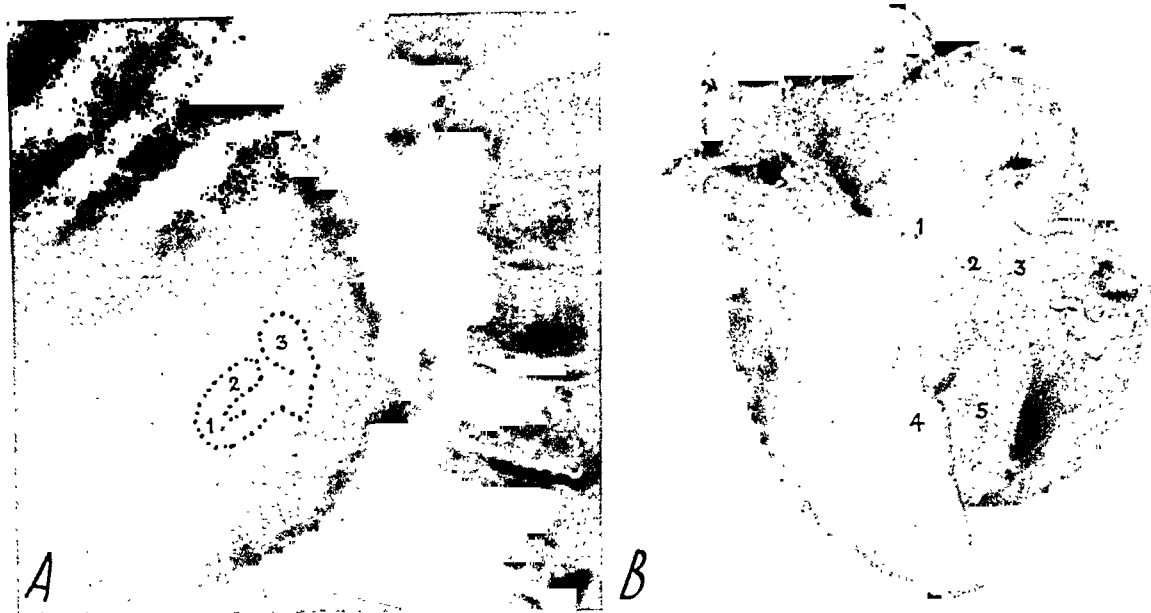


FIG. 9. Case v of Table I. Complete atrioventricular block, alternating with 2:1 block. *A*, left lateral roentgenogram shows faint calcium deposits, incomplete mitral ring calcification with nodular thickening of area of left trigonum. *B*, specimen of same case shows complete ring calcification. This was not evident on the roentgenograms. 1, area of right fibrous trigonum. 2, intertrigonal space. 3, left fibrous trigonum. 4, anterior papillary muscle. 5, posterior papillary muscle.

cases of heart block and two in 21 cases without heart block were found. At times, heavier deposits were seen in that part of the completely calcified ring which corresponds to the area of the posterior (right)

trigonum and to adjacent parts of the septum.

3. *Incomplete ring calcifications at the mitral ostium.* This type found in 2 of the 12 cases is less specific than either of the

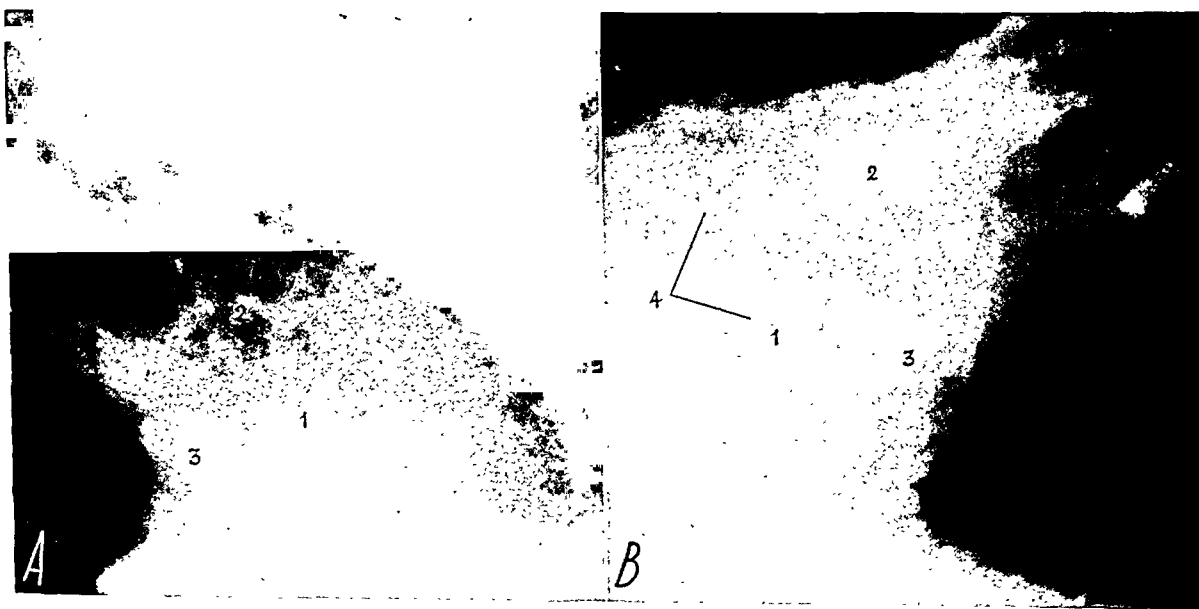


FIG. 10. *A*, incomplete ring calcification. No heart block. Male, aged sixty-three. No symptoms of cardiac disease. Left oblique view. *B*, same case one year later, right oblique view. Note extension of calcification from area of the right trigonum toward the septum and the aortic ring. 1, area of right (posterior) fibrous trigonum. 2, area of left (anterior) fibrous trigonum. 3, posterior branch of calcified mitral ring. 4, new extension of calcifications from the right trigonal area.

previous types. It was found almost as frequently in cases without heart block as in cases with heart block. It consists of irregular broadening of the calcium shadow at the right end of the mitral annulus corresponding to the right trigonum. Considering the spatial relationship, it is reasonable to believe that in cases of heart block, calcium deposits located in the right fibrous trigonum may extend into the bundle of His, or that it is damaged by degenerative changes preceding the calcifications.

#### SUMMARY

1. Anatomical and pathological fundamentals of calcifications in the membranaceous septum and the technique of their roentgenological localization and identification are described.

2. Twelve cases of heart block are presented. In ten of these cases septal calcifications were observed roentgenologically during the lifetime of the patient.

3. Three types of roentgen signs are recognized which are considered as indicative of the presence of calcareous deposits in the membranaceous septum.

(a) Caudad extension of calcium shadows from calcified aortic valves or aortic ring.

(b) Complete circular or crescent-shaped calcifications about the mitral ostium.

(c) Incomplete mitral ring calcifications with nodular thickenings of calcareous deposits at the right (medial) end of the posterior branch of the calcified mitral ring.

4. Roentgen signs of calcium deposits in the septum are as a rule associated with heart block or prolonged conduction time.

5. At times calcifications can be demonstrated roentgenologically in the septum with no clinical or electrocardiographic signs of heart block.

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# UMBRATHOR AS A SUBSTITUTE FOR BARIUM IN THE ROENTGEN STUDY OF ACUTE INTESTINAL OBSTRUCTION\*

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**E**MPLOYMENT of the roentgen rays in the study of cases of possible intestinal obstruction has become an established means of diagnosis. Not infrequently the presence of an accumulation of more or less inspissated barium above an obstructive lesion has caused considerable inconvenience and on at least a few occasions a serious menace to the life of the patient.

It has become good practice to begin the gastrointestinal study with the opaque enema in all cases where an obstructive lesion is suspected, and under such circumstances the radiologist should exercise great care not to force any considerable amount of barium through the stricture into the bowel proximal to the obstruction. Indeed, this feeling has been so strong in some circles that barium studies have been forbidden in cases of suspected obstruction, and an attempt has been made to use sodium iodide in about the same strength as has been employed by the urologist in cystography.

The writer has employed barium in small quantities in cases of suspected acute small bowel obstruction in a great many instances and only once has he found the presence of the barium an inconvenience to subsequent surgery. In fact, the presence of barium in the lumen of the obstructed bowel can be detected very easily by visual examination of the obstructed bowel, for the thinned wall of the dilated bowel permits one to detect the whitish discoloration of the bowel content. One may thus know when he is above the obstruction. The writer has made it a rule over many years never to employ barium in any investigation of the gastrointestinal tract shortly

after a gastro- or entero-anastomosis. He has never seen any embarrassment from thus studying a gastroenterostomized patient, but he does recall distinctly a case in which an enteroenterostomy was found at post-mortem to be lying wide open with an amorphous mass of barium occupying the lumen at the site of the obstruction.

As far back as 1915 and, indeed, several years prior to that date, the writer advocated the study of the gas-filled coils of bowel without the use of barium as being sufficiently informing in cases of acute small intestine obstruction. The herringbone appearance of the small bowel could be distinguished even though no opaque material had been administered, and the stepladder arrangement of the dilated coils, previously described by Treves before the era of the roentgen ray, could be easily identified on roentgenograms. Indeed, for most studies of acute postoperative ileus a scout film of the abdomen is sufficient, it being possible to make the necessary deductions from the observation of gas-filled loops of intestine.

More precise information, however, can be obtained if some opaque medium is available, and since 1930 the writer has employed as an opaque medium in cases of suspected obstruction anywhere in the digestive tube, both for oral and for rectal administration, an aqueous preparation of thorium dioxide, known commercially as *umbrathor*. This is a slightly astringent, slightly turbid liquid, scarcely less fluid than water itself, which can be swallowed by the patient or passed into the stomach through a tube or which can be injected per anum. It gives a shadow of very great

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density, equal to or even better than the shadow given by a suspension of barium sulfate. It has the advantage of being always liquid; there is no danger of the opaque material sedimenting out of the solution. It, therefore, presents great advantages, and in the writer's experience it has been found to be very useful in the study of all cases of suspected gastrointestinal obstruction. In colonic studies in which one wishes to depict the mucosal folds umbrathor is especially useful. For a similar purpose it is valuable in the stomach, but its greatest value in the writer's experience is in cases of suspected obstruction, acute or chronic.

Vomiting, even vomiting of fecal-tinged material, does not contraindicate the administration of umbrathor by mouth. The writer has seen numerous instances of successful jejuno-ileal visualization by the use of umbrathor administered to patients who were vomiting. It is a common observation that patients seldom, if ever, vomit anything like the total content of the stomach, and even if a small part of the gastric content of umbrathor survives the vomiting, it will serve the purpose.

The patient should be given about 50 cc. of umbrathor to which is added an equal quantity of plain water, preferably cold. It may be given in one single dose or in divided doses over an hour or an hour and a half. If the patient already has a nasal or Rehfuß or Wangenstein tube in place, it is a simple matter to inject the 100 cc. of diluted opaque material and to clamp off the tube for an hour or so. The one important requisite is that the patient be kept for an hour or two in a position which will facilitate the emptying of the stomach. This means that he must lie on the right side, almost face down, if not completely prone. It is a well-known fact that such position facilitates emptying of the stomach.

The roentgenograms may be made at the bedside if it is deemed undesirable to move the patient to the roentgen department.

This bedside procedure was recommended by the writer more than thirty years ago. It is not necessary to turn the patient face down for the roentgen films. The purpose is served equally well if the patient lies supine upon the film, although additional information is sometimes obtained by having him sit or stand erect or, if that is not feasible, lie upon the right or left side, with the film held vertically and the roentgen rays passing parallel with the floor in order to demonstrate a possible fluid level.

In this manner it is possible to supplement the roentgenograms made without the administration of opaque material and to obtain much more precise information as to the site and degree of an intestinal obstruction.

The employment of umbrathor in this manner is so simple and so free from complications one wonders why it would not be a good routine hospital procedure to leave a standing order with residents or house physicians that every case showing any suspicion of acute intestinal obstruction should be given a dose of umbrathor on the appearance of the very first suspicious symptoms. Should the subsequent course of this suspected patient prove the question of ileus a false alarm, no harm has been done; on the contrary, should the symptoms of ileus progress to a point where a roentgen survey film of the abdomen is desirable, the opaque material will be already in place, and the first roentgenograms all the more valuable.

#### SUMMARY

The use of the roentgen ray in examining cases of suspected acute intestinal obstruction is an established procedure, dependence being placed upon the study of gas-filled coils or fluid levels discernible in the intestine proximal to the obstruction.

Administration by mouth or by rectum, as the case may demand, of umbrathor, mixed with an equal quantity of water, materially improves the chance of recognizing the degree and site of the obstruction



without danger of making the situation worse.

Such administration of umbrathor is recommended as a routine standing order for all cases of suspected ileus, to be administered at the first sign of obstruction.

Such administration is harmless if the procedure proves to be unnecessary, and time- and life-saving if the ileus develops further.

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# ROENTGEN FINDINGS IN PRIMARY DUODENAL AND PARADUODENAL MALIGNANT LESIONS

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THE history of the diagnosis and treatment of cancer of the duodenum, cancer of the ampulla of Vater, and cancer of adjacent structures has been one of slow but steady progress.<sup>10,14,25</sup> The difficulties that still persist, as in all malignant conditions, are those of early diagnosis, and radical, successful, surgical removal. At the present time, nothing offers a greater opportunity for the early diagnosis of these lesions than roentgen studies.<sup>29,30,32</sup> Of course, this means that the patient must be referred to the roentgenologist before the lesion is too advanced for successful surgical removal.

In this paper, we will discuss the roentgenologic aspects of these various lesions and briefly mention the results that can be expected from early surgical removal. Cases will be presented to illustrate these lesions.

Carcinoma of the duodenum, while admittedly a rare condition, must be borne in mind when considering lesions of the upper gastrointestinal tract.<sup>17,23</sup> At the present time, over 400 proved cases of this condition have been reported in the literature.

According to Eger,<sup>12</sup> Hoffman and Pack,<sup>19</sup> and Berger and Koppelman,<sup>3</sup> 0.03 per cent of all carcinomas; 0.3 per cent of all intestinal carcinomas; and 45 per cent of all small intestinal carcinomas occur in the duodenum. Of these, 20 per cent are suprapapillary, 65 per cent peripapillary, and 15 per cent intrapapillary. In this lesion, males predominate three to one. This is confirmed by many authors.<sup>7,22</sup>

Carcinoma of the duodenum has long been a diagnostic problem. Up to the present time, the diagnosis has most often been made at operation or postmortem examination. Bastos,<sup>33</sup> and Mateer and Hartman,<sup>24</sup> made the diagnosis preoperatively by roentgen examination. Herman and von

Glahn<sup>18</sup> missed the lesion on the roentgenograms preoperatively, but were able to demonstrate the lesion on the roentgenograms in retrospect.

Early in the course of this disease, before the advent of metastases or involvement of adjacent structures, it is very difficult to make the correct diagnosis by clinical means. Probably the most constant finding is occult blood in the stool as is usually the case in lesions eroding the intestinal mucosa. This finding is apt to be accompanied by a mild secondary anemia.

Although not always present, the most common complaint that these patients present is that of upper abdominal pain. This pain may vary from slight to severe, may be constant or intermittent, and may or may not have a relation to meals or the time of day. The symptoms of weight loss, vomiting, and jaundice, when the common duct is involved, are moderately late clinical signs, and mean that the lesion has advanced beyond the stage in which we wish to make the diagnosis.

Of course, the symptoms and the roentgenographic picture depend on the location and type of lesion.<sup>11</sup> In the suprapapillary portion of the duodenum the lesion is usually a constricting one; narrowing the lumen, and infiltrating and eroding the mucosa. These lesions are usually scirrhous adenocarcinomas.<sup>33</sup> In this type, the most common symptom is pain, and the stool is frequently positive for occult blood.

In the peri-ampullary portion, the lesion may be a constricting adenocarcinoma, as described above, producing the same signs and symptoms. In addition, this lesion, if arising near the papilla of Vater, may very early infiltrate the papilla, causing a blockage of the flow of bile into the duodenum. This is the one example of carcinoma of the

duodenum in which jaundice and light-colored stools can occur very early in the course of the disease.

Papillary adenocarcinoma is another example of carcinoma of this portion of the duodenum. Early in its course, before the base has infiltrated the mucosa and submucosa enough to cause constriction of the lumen, there may be no complaints referable to the lesion. However, the patient may complain of mild, intermittent, upper abdominal pain. The stool is often positive for occult blood, and an accompanying secondary anemia may be present.

Carcinoma of the infrapapillary portion of the duodenum is the least common of these lesions.<sup>7</sup> Up to December, 1944,<sup>31</sup> there were 12 cases of primary carcinoma of the third portion reported in the world literature, in which resection was done. This lesion, which usually occurs near the duodenojejunal junction, is most often an infiltrating, constricting adenocarcinoma. Here, as in the first portion, the lesion is more scirrhous than glandular in nature. Carcinoma of this portion, too, has a tendency to metastasize earlier than lesions in the other two portions of the duodenum. Because of its location, symptoms appear somewhat later than in the lesions described above. The most frequent symptom, again, is pain; and occult blood may be present in the stool.

One of the early symptoms of any of these lesions may be a massive hemorrhage. This occurs when the lesion erodes into a fair sized vessel. If this occurs in the suprapapillary area, the patient may have massive hematemesis. In the peripapillary and infrapapillary areas, the hemorrhage may take the form of tarry stools or even a bloody diarrhea.

Only the most careful study after ingestion of a barium meal will reveal these early lesions to the roentgenologist. The appearance varies with the type and location. In the suprapapillary portion, the roentgenoscopist may see a very small protuberance jutting into the lumen, with the mucosa destroyed over the area. There is no as-

sociated spasm or tenderness such as one finds in inflammatory lesions of this area. One cannot emphasize too strongly that this lesion may be very small and the existing pathology can be completely missed in a hurried or careless examination. When the lesion is demonstrated by the roentgenoscopist, a permanent record can be obtained by taking spot roentgenograms of the area immediately. In addition, mucosal detail can be visualized more clearly and sharply on a film than by roentgenoscopic means.

Carcinoma of the peripapillary portion may present exactly the same findings as described above.<sup>1</sup> However, the lesions in this portion have a tendency to be papillary adenocarcinomas. Being papillary, they protrude into the lumen and present much more of a filling defect with mucosal destruction than the more scirrhous lesion described above. There is no way in which the roentgenologist can determine whether he is dealing with a primary adenocarcinoma of the duodenum or a carcinoma of the ampulla of Vater. Only the pathologist is able to make this differentiation.

Another condition occurs in the duodenum which the roentgenologist must keep in mind when dealing with a filling defect of this area. Baylin<sup>2</sup> presented a case diagnosed as a carcinoma of the ampulla of Vater roentgenologically which, when operated upon, proved to be a cluster of aberrant pancreatic tissue protruding into the lumen of the duodenum just above the papilla. This finding of pancreatic tissue in the duodenal wall is easy to understand when one considers that embryologically, the pancreas originates as buds from the duodenum.<sup>2</sup> The differential diagnosis between this lesion and the malignant lesion described above is made by the lack of destruction and distortion of the mucosal pattern occurring over the benign pancreatic tissue tumor.

Baylin,<sup>2</sup> Lehman,<sup>21</sup> and Gross and Chisholm,<sup>16</sup> described another condition occurring in the second portion; that of annular pancreas surrounding, constricting and ob-

structing the duodenum. This lesion should not cause too much difficulty in differential diagnosis as the mucosal folds should appear intact right through the area of constriction.

Malignant lesions of the third or intrapapillary portion of the duodenum are of the scirrhous adenocarcinoma variety. These lesions have a tendency to infiltrate the bowel wall and constrict the lumen, as has been mentioned before. The majority occur near the duodenojejunal junction. Because of the location, symptoms sufficient to bring the patient to a physician occur somewhat later than in lesions in the other two portions of the duodenum. Because of this, the earliest finding observed by the roentgenologist may be an area of narrowing of the lumen in the last part of the duodenum. One will also see destruction and distortion of the mucosal folds and loss of distensibility and pliability of the wall. Of course, the roentgenologist may occasionally have the opportunity of doing the gastrointestinal examination at the time when the lesion produces only the minimal findings described previously.

Again, aberrant pancreatic tissue tumors may occur in this portion of the duodenum. Brown, Flachs and Wasserman<sup>4</sup> reported a case of a stenosing lesion of the ascending duodenum which was interpreted roentgenologically as a neoplasm of the third duodenum. Surgery revealed the lesion to be caused by aberrant submucosal pancreatic tissue. The mucosa over the lesion was normal.

We wish to emphasize the role that the mucosa plays in the diagnosis of the lesions described above. Malignant lesions of the duodenum both destroy and distort the mucosal pattern. These changes can be seen by roentgenoscopic examination and roentgenograms of the gastrointestinal tract following ingestion of a barium meal. If a lesion is present encroaching on the lumen of the duodenum which does not change the mucosal pattern, it is most likely benign or extrinsic.

The history and findings of a patient with a primary carcinoma of the duodenum are presented below.

**CASE 1.** The patient, white female, aged sixty, was admitted to the Buffalo General Hospital in October, 1944. For the ten years prior to admission, she had complained of an aversion to fried and fatty foods and had noted, also, constipation and indigestion. Also, she had had occasional attacks of right upper quadrant pain, occurring every two to three months, and necessitating one to two days' rest in bed. These attacks were usually followed by clay-colored stools for one to two days. Occasionally, clay-colored stools occurred without pain. The patient had had a gallbladder attack with pain, nausea, vomiting, jaundice, and clay-colored stools, in 1939. This attack was supposedly followed by a pancreatitis. The patient stated that she developed diabetes mellitus following that attack and required 24 units of protamine-zinc insulin daily thereafter. She had had one more such episode with jaundice before she developed the chain of symptoms that preceded her admission to the Buffalo General Hospital.

During the year preceding admission, she complained of fatigue, an accompanying anemia and had had a moderate anorexia with about a 40 pound weight loss. The patient had been under the care of a physician with no improvement in her condition. About eight months before admission, the patient noticed that she was running an occasional fever of 101 to 104° F. The fever would subside overnight. Six months before admission the patient began to have occasional chills, lasting thirty minutes or more, and occurring about once a week. About three weeks before admission, the patient developed a jaundice, which gradually increased in intensity.

The patient stated that she had had pain for six months before admission which was different from the occasional attacks of pain described above. This pain was of a lesser intensity, moderately steady in nature, and more toward the midline.

Examination on admission revealed a marked icterus. The liver was palpable, one fingerbreadth below the costal margin. There was a firm, non-tender mass about 8 cm. in diameter felt in the mid-epigastrium. There was also a cystic lemon-sized mass, which was respiratory motile, in the right flank.



FIG. 1. Case 1. This shows the huge filling defect in the second portion of the duodenum with complete destruction of normal mucosal pattern and actual enlargement of the duodenum by mass of the lesion. In spite of the size of this lesion, there was no appreciable obstruction.

### *Laboratory Findings.*

#### *Blood studies:*

10-7-44: Red blood cell count—3,650,000.  
Hemoglobin—85 per cent.  
White blood cell count—8,100.

#### *Differential—Bands—50.*

Filaments—17  
Eosinophils—1.  
Lymphocytes—19.  
Monocytes—13.

#### *Urinalysis:*

10-9-44: Glucose—±.  
Bilirubin—weakly positive.  
Urobilogen—strongly positive.

#### *Stools:*

10-9-44: clay-colored—positive for blood.  
10-10-44: clay-colored—positive for blood.  
10-12-44: grayish-black—positive for blood.

#### *Icteric index:*

10-19-44: 15-20.

#### *van den Bergh:*

10-9-44: prompt—1.0 mg.  
10-8-44: Prothombin time—19 sec.  
Serum protein—5.3 mg. per cent.  
Serum albumin—3.7 mg. per cent.  
Alkaline phosphatase—17.7 Bodansky units.

*Roentgen examination* of the gallbladder with oral dye showed non-visualization. Plain roentgenogram of the abdomen showed a moderate degree of splenic enlargement.

Study of the stomach was negative. Study of the duodenum showed a polypoid new growth involving almost the entire second portion of the duodenum, with a marked degree of distortion and mucosal destruction; however, this produced no obstruction to the flow of barium. Our conclusion was a polypoid new growth in the second portion of the duodenum.

The patient was studied for eleven days. There was no change in the findings described above. A laparotomy was done on the twelfth day. The tissues were found to be jaundiced, as was the small amount of free peritoneal fluid. The liver was generally enlarged and granular in appearance. It had a thick border, but contained no palpable nodules. The gallbladder was of huge size but not inflammatory. The common duct was dilated. The stomach and duodenum seemed normal, but a retroperitoneal tumor mass the size of a small grape-fruit was present which seemed to have its origin in the pancreas and involved practically the entire organ. Extending both above and below the pancreas were numerous nodules, apparently metastatic nodes. The lesion itself seemed to be not removable because of these extensions. In order to alleviate the jaundice, a cholecystojejunostomy was performed. The lesser cavity was opened and a biopsy was taken from the pancreatic tumor.

The pathological report on the biopsy from the pancreas was a distinct carcinoma of solid tubular type, with mucoid degeneration in some of the cancer cells and forming small alveolar structures.

The patient's postoperative condition was fair until the third postoperative day, when she became very distended, markedly icteric, and moribund. The patient died on the fourth postoperative day.

Postmortem examination revealed that the patient died of a peritonitis following volvulus of a mobile cecum.

There was a huge, fairly round and markedly ulcerated and necrotic papillary malignant tumor growing in the mucosa of the second portion of the duodenum and measuring 11.5 by 8 cm. The proximal edge of the tumor was situated 3 cm. distal to the pylorus. The edge of the tumor was distinctly elevated, while its center was considerably ulcerated and markedly

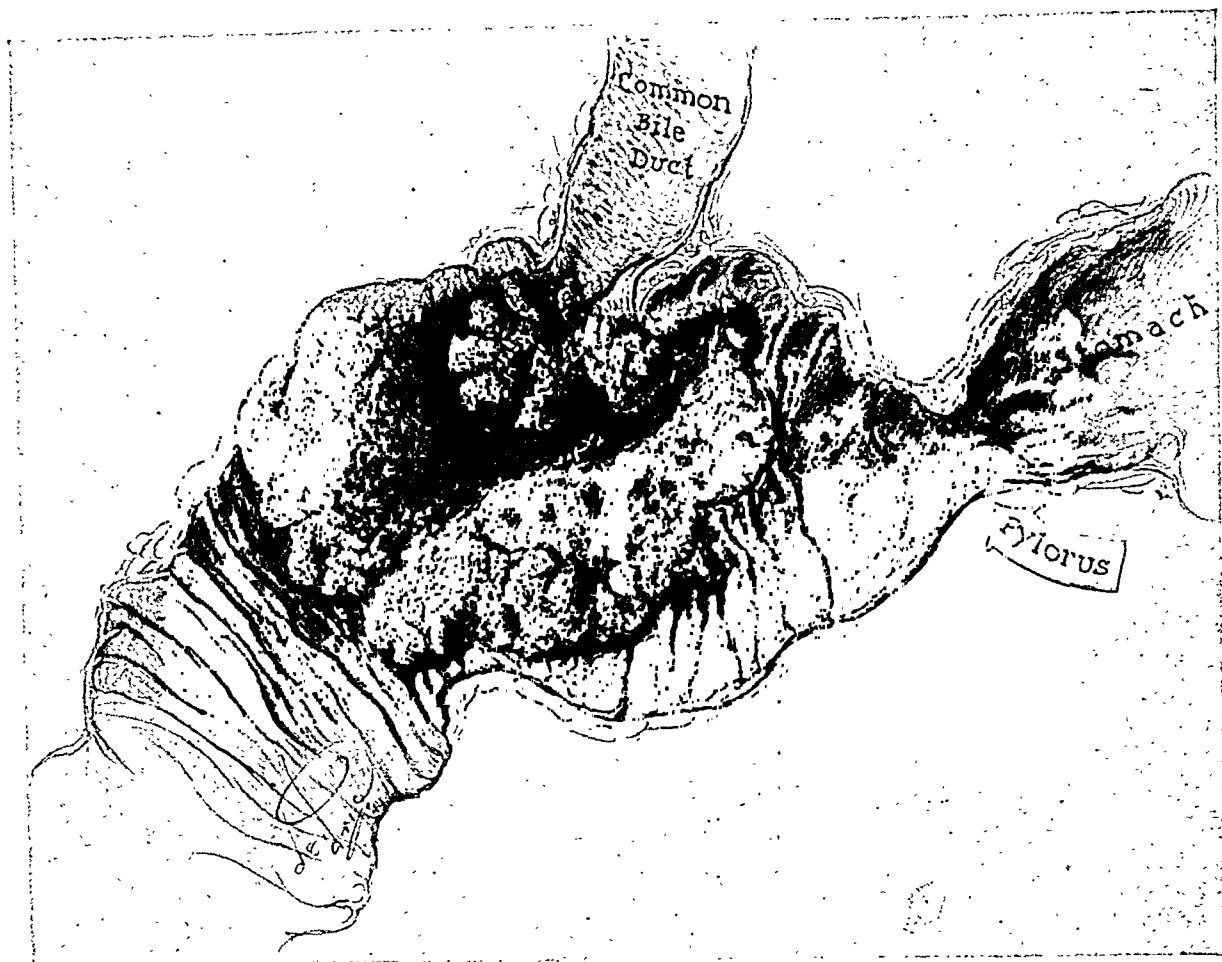


FIG. 2. Drawing of pathological specimen from Case 1. This correlates very well with the roentgenogram of this case as to distribution, size and type of lesion.

necrotic, with papillary, cauliflower-like protruding tumor nodules.

The biliary system and pancreatic duct were dilated but otherwise not involved in the lesion.

There was no gross evidence of metastatic tumor in the periaortic or retroperitoneal lymph nodes, which were all of average size. There were a few bean-sized, fairly soft lymph nodes in the hilus of the liver, one of which showed a large, frankly yellow nodule on cut section, probably metastatic tumor.

*The chief diagnoses were:* (1) unusually mobile cecum with volvulus through 180 degrees, and recent fibrinous peritonitis; (2) huge primary, distinctly ulcerated carcinoma of the duodenum; (3) chronic cholecystitis with cholecystolithiasis and choledocholithiasis.

Carcinoma of the ampulla of Vater is often indistinguishable from primary adenocarcinoma of the duodenum both roentgenographically and clinically. Even the pathologist, on occasion, has difficulty

in making a definite differential diagnosis between these two lesions.

Because of its location, this lesion may very early obstruct the opening of the common duct. Jaundice is an early sign, as are light-colored stools. Again, as in carcinoma of the duodenum, the stool may be positive for occult blood and there may be an accompanying secondary anemia. A very small carcinoma of the ampulla of Vater can completely occlude the opening of the common duct. This causes back pressure in the extrahepatic bile ducts, and distention of the gallbladder. Cooper<sup>9</sup> states that carcinoma of the ampulla can be diagnosed by the following findings: (1) roentgenographic evidence of a duodenal lesion; (2) occult blood in the stool; (3) secondary anemia; (4) jaundice; and (5) palpable gallbladder. Erb<sup>13</sup> suggests that a diagnosis between a jaundice arising from a

malignant lesion obstructing the common duct and a jaundice of hepatocellular origin can be made by blood studies; van den Bergh test, icteric index, etc; clinical signs and symptoms; and visualization or non-visualization of the gallbladder by roentgen examination following ingestion of radiopaque dye.<sup>15</sup>

Outerbridge<sup>27</sup> states that there seems to be a relationship between carcinoma of the ampulla of Vater and cholelithiasis. In his report of 110 cases of carcinoma of the ampulla, there was a much higher incidence of biliary calculi than occurs in the general population. However, just what this relationship is has never been determined.

Although a correct, early diagnosis is not always possible, carcinoma of the ampulla of Vater produces symptoms that are dramatic to the patient and cause him to seek treatment while the lesion is still localized. This is a somewhat fortunate occurrence, as carcinoma of the ampulla has a tendency to metastasize earlier than carcinoma of the duodenum. Carcinoma of the ampulla spreads by lymphatic extension around the wall of the duodenum, causing an annular constriction.<sup>9</sup> This lesion also metastasizes early to the lymph nodes between the pancreas and the duodenum, to the preaortic nodes, and to the periportal nodes. The lesion does not invade the pancreatic acini but does invade the areolar tissue between the lobules.<sup>9</sup>

Carcinoma of the ampulla may be papillary or infiltrating in nature. Both lesions erode the mucosa and cause bleeding. Some tumors of the ampulla may be benign. Outerbridge<sup>27</sup> reported 9 such cases collected from the literature. These tumors do not erode the mucosa, do not cause bleeding, and do not present a secondary anemia. However, such a benign tumor can occlude the common duct with its attendant signs and symptoms.

The patient who has deep jaundice, marked weight loss, and signs of duodenal obstruction, has a long-standing lesion with probable metastases. There is very little hope of successful surgical removal. The

lesion must be diagnosed before these signs and symptoms appear.

Carcinoma of the ampulla of Vater can be diagnosed early roentgenographically, although, as we have mentioned, the lesion sometimes cannot be differentiated from a primary duodenal carcinoma. Under the fluoroscope, following the ingestion of a barium meal, one may see a small filling defect protruding from the posteromedial or medial wall of the second portion of the duodenum. This lesion is usually 2.5 to 3 cm. below the junction of the first and second portion of the duodenum. The mucosa over this area may be eroded and distorted. If the lesion has infiltrated the duodenal wall along the lymphatic channels, there will be a narrowing of the lumen of the duodenum at the level of the lesion. Carcinoma of the ampulla does not always produce a filling defect and perhaps the only finding visible to the roentgenoscopist will be an erosion of the mucosa in the papillary area. In this lesion, as in primary carcinoma of the duodenum, spot roentgenograms of the area are of great value in determining the actual amount of mucosal destruction.

The roentgenologist should be aware of the possibility of such a lesion being present and search diligently for it when doing the gastrointestinal examination. Only the most careful, painstaking examination will disclose these early signs of ampullary carcinoma.

Below is a report of a case of a very early carcinoma of the ampulla of Vater, which, although it was not positively diagnosed, was indicated and suggested following a roentgenographic examination.

CASE II, a white female, aged sixty-two, was admitted to the Buffalo General Hospital on December 30, 1945. She was perfectly well until July 1, 1945, when she developed a severe itching of the skin. No lesions were present. She visited several physicians without relief. About three weeks after the onset of the itching, the patient developed a jaundice of her skin and eyes. She had a slight fever for a few days. There were no complaints of pain nor chilly sensations. She noticed that her urine was unusually dark and that her stools were light-

colored. She visited another physician and was told to avoid fatty foods. The jaundice lasted for about three weeks. Both the icterus and pruritus subsided at the end of this time. However, the patient continued to lose weight. She thought it was due to her somewhat limited diet from avoiding fatty foods, and did not worry about it as she was somewhat obese.

The patient was well after the above episode until about six weeks before admission. At this time the itching returned, more severe than formerly, and it was accompanied by a less pronounced, and even questionable, icterus. She had a fever of about 100° F. There was no history of pain or chills. She did give a history of dark urine and light-colored stools. She had never had any nausea or emesis, but complained of occasional gas pains after eating.

The above symptoms continued until admission. At this time, she had lost 20 pounds in weight since the onset of pruritus in July.

Physical examination on admission revealed a slight icteric tint to the skin and conjunctivae. There was evidence of some excoriation. The abdomen was soft, non-spastic, and non-tender. The liver was palpable, one finger-breadth below the costal margin on expiration, and it was smooth and not tender. The spleen was not palpable.

Roentgenographic examination of the stomach and duodenum showed a slight deformity in the second duodenum in its lower portion at the posteromedial aspect. The mucosa did not appear destroyed, although somewhat irregular in appearance. At the end of four hours the stomach was empty, with the head of the meal in the transverse colon. The findings were not conclusive, but we were suspicious of a lesion at the ampulla of Vater and suggested further study with such a lesion in mind.

The *laboratory findings* were as outlined below:

#### *Urinalysis:*

12-31-45: Bilirubin—slightly positive—1:20.

1- 2-46: Slight trace of albumin.

Bilirubin—slightly positive—1:40

5-10 red blood cells; 3-5 white blood cells per high power field.

#### *Blood Studies:*

Red Blood Cell Count:

12-31-46: 3,900,000 with 10.9 grams hemoglobin.

White Blood Cell Count:

12-31-45: 10,000 with 26 bands; 47 filaments; 1 eosinophil; 21 lymphocytes; 5 monocytes.

#### *Blood hematocrit:*

12-31-45: 43

Sedimentation rate, 43.

#### *Icteric index:*

12-21-45: 25-50 with van den Bergh prompt 1.6 per cent.

1- 7-46: 100 plus with van den Bergh prompt 5.6 per cent.

#### *Prothrombin time:*

12-31-45: 16 seconds; Cephalin flocculation—negative.

*Blood glucose:* urea nitrogen, serum albumin, serum globulin, blood chlorides—normal.

#### *Alkaline phosphatase:*

12-31-45: 48 Bodansky units.

1- 2-46: 39.5 Bodansky units.

#### *Feces:*

1-1-46 and 1-2-46: 2 plus blood, and positive for bile.

There was no change in the patient's condition following admission. She was prepared for surgery and operated upon on her sixth hospital day. At operation the liver seemed slightly enlarged, otherwise normal in appearance. There was no discoloration of the viscera and no free fluid. The stomach and first portion of the duodenum appeared normal. The gallbladder was somewhat thickened, slightly tense, but not distended. Because of its tenseness, normal appearing bile was aspirated which made it possible to palpate several small stones. The duodenum was mobilized, exposing the common duct, which was markedly dilated. The cystic duct, as well, was dilated. No stones were palpable in the common nor cystic ducts. Palpation of the pancreatic portion of the common duct, immediately adjacent to the duodenum, revealed a hard nodule the size of a small walnut, round and relatively smooth. It was decided that this was a malignant tumor. There seemed to be no extension nor fixation of surrounding tissue and there was no suggestion of any metastatic lesion in the peritoneal cavity. The great bulk of the pancreas was normal in appearance and consistency.

As the patient was a good risk and in good condition, a primary resection of the head of the pancreas was done, and followed by a retrocolic Polya gastrojejunostomy and a cholecystojejunostomy.

Examination of the resected gross specimen showed a malignant tumor originating or ex-





FIG. 3. Case II. Views of the duodenum in right anterior oblique and prone positions. Circle surrounds the small filling defect at the posteromedial aspect of the duodenal wall. This corresponds to the approximate position of the papilla of Vater.

tending into the pancreas, and present in the duodenum adjacent to the ampulla.

The pathological report was as follows:

Macroscopic: Resected first and second portion of the duodenum, including pyloric ring, with papillary cancer of the papilla of Vater,

about 3 cm. in diameter. There was a portion of the common duct 6 cm. long, in connection with the specimen, already opened. Circumference distal to the papilla was about 2.2 cm.

Microscopic: Primary carcinoma, involving the entire papilla, of typical glandular type,

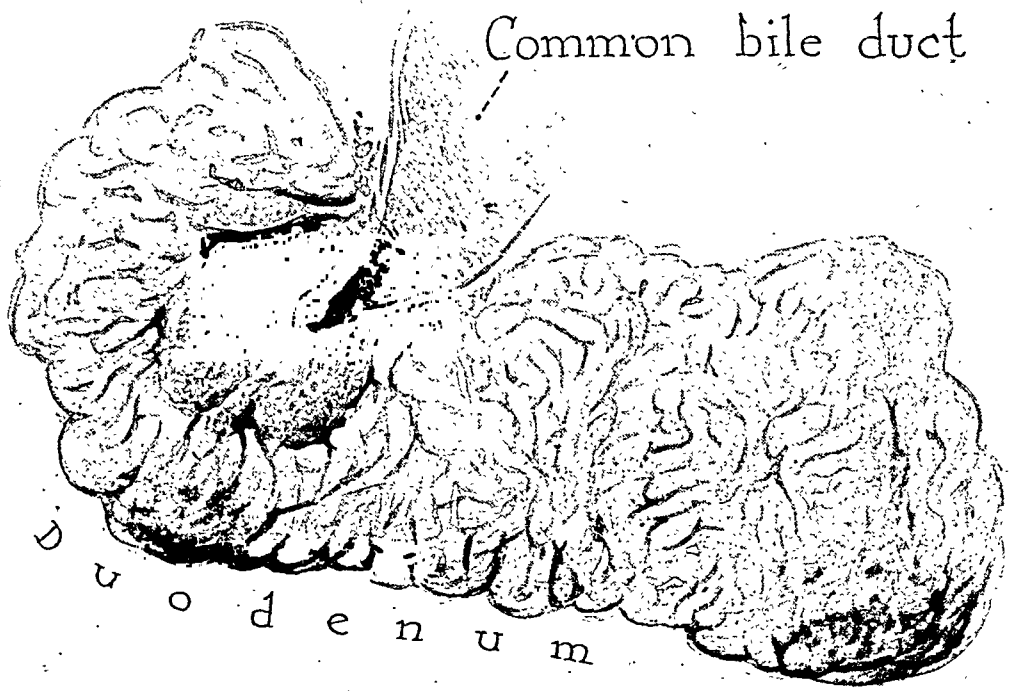


FIG. 4. Drawing of the surgical specimen from Case II. The small tumor at the ampulla corresponds exactly with the lesion demonstrated roentgenographically.

with considerable mucoid secretion; with localized and fairly restricted nodular carcinomatous infiltration within a small portion of the closely attached pancreas. The bulk of the pancreas removed with the specimen was free of cancer. The exact site of the origin of the tumor could not be determined accurately. There was considerable anaplasia in some parts of the tumor, frequently nearly solid tubules, and rather massive infiltration of a few lymph nodes closely attached to the wall of the duodenum at the site of the tumor.

Sections taken through the common duct contiguous to the cancer did not show any carcinomatous infiltration.

The patient's postoperative course was attended by fever, tachycardia, and shock-like states. Although she responded somewhat to fluids and oxygen, her course was steadily retrogressive. She died on January 8, 1946.

No autopsy was performed.

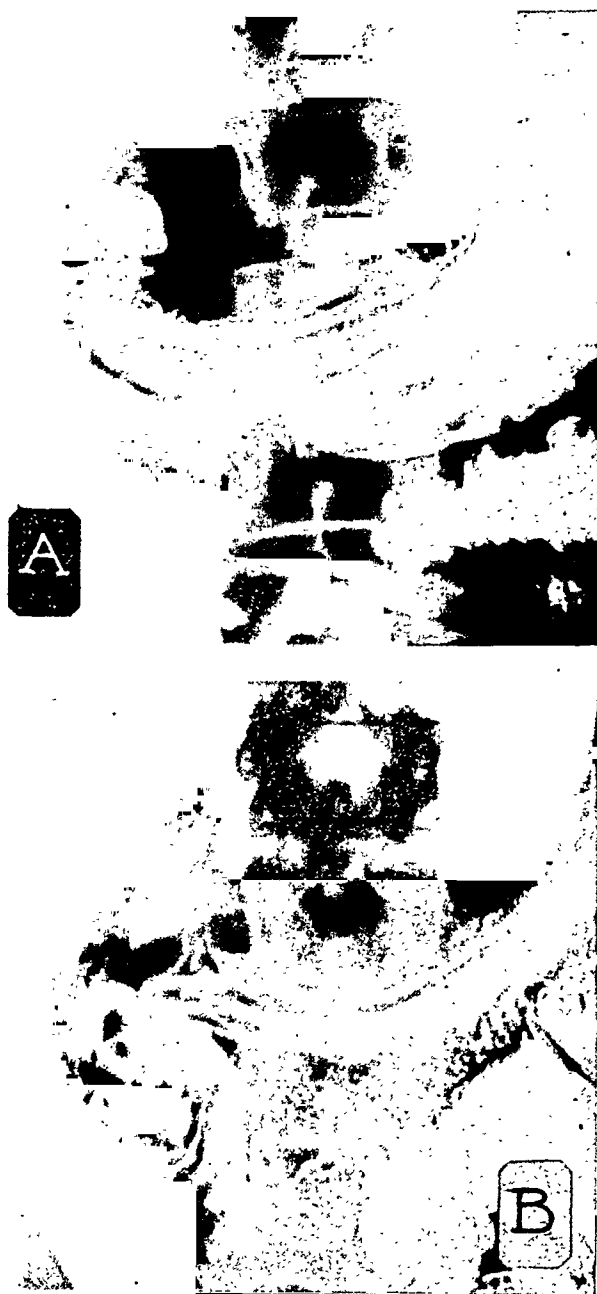
Another patient with a carcinoma of the ampulla of Vater was studied in this department. However, in this instance, the lesion, although of considerable size, was not diagnosed roentgenographically. On review of the roentgenograms following postmortem examination, the lesion could be recognized.

A report of this case follows.

**CASE III.** A white female, aged forty-five, was admitted to the Buffalo General Hospital on October 20, 1945. She had been in good health until November, 1944, when she began to notice generalized weakness and malaise. She visited a physician and was told that she had an anemia and blood in her stool. A roentgenographic examination of the gastrointestinal tract following the ingestion of a barium meal was done in this department but no abnormalities were noted.

The patient was treated for the anemia and improved under treatment. The patient continued to improve as long as treatment was continued but symptoms returned when treatment was stopped. In July, 1945, this department again studied the patient, and again nothing unusual was found.

In August, 1945, the patient developed a moderate diarrhea which lasted intermittently until four to five days before admission. The patient's anemia continued, as did the blood in the stools. In October, 1945, the physician



**FIG. 5.** Case III. *A*, roentgenogram made on November 27, 1944. Even in retrospect no abnormalities can be noted in the second portion of the duodenum. *B*, roentgenogram made on October 22, 1945. This shows a polypoid filling defect involving the inferior part of the second portion of the duodenum with mucosal destruction and distortion. This lesion also enlarges the duodenum by its mass. Notice the resemblance to the roentgenogram of Case I.

noticed that the patient was mildly jaundiced and admitted her to this hospital to determine the source of jaundice and gastrointestinal bleeding.

On admission, the patient stated that she

had never noticed blood in the stools, but that the stools were black when she was taking medicine for her anemia. She stated that for the week prior to admission her stools had been grayish in color. She did not notice the jaundice until she was informed of its presence by her physician.

The patient had epigastric soreness for the week prior to admission. This had no relation to meals nor time of day. She did not complain of nausea, vomiting or anorexia.

Examination revealed a mild icterus and a liver enlarged two finger-breadths below the right costal margin. The liver was smooth and non-tender.

Urinalysis on admission showed a positive test for bilirubin and a slightly positive test for urobilinogen. The red blood count was 3,500,000, with 8.3 grams of hemoglobin. The white blood count was 4,500 on admission with 85 per cent polymorphonuclear cells. This subsequently rose to 36,000 with 92 per cent polymorphonuclear cells. Serum albumin on admission was 3.8 and the serum globulin was 2.2. The sedimentation rate was 41 mm. The patient had an icteric index of 75-100 with a prompt van den Bergh of 4.8 mg. per cent. All samples of the stool were 4 plus on test for blood.

Our department again did a gastrointestinal examination and for the third time no abnormalities were found.

The patient's course was somewhat retrogressive with further enlargement of the liver, diffuse abdominal pain and distention, nausea, vomiting, and right upper quadrant abdominal tenderness. The patient was prepared for surgery and operated upon on November 1, 1945.

Laparotomy revealed a large amount of bile-stained purulent fluid in the abdomen. The liver was markedly swollen. No perforation of the gastrointestinal nor biliary tracts was found. The gallbladder was distended with bile but no stones were present. The pancreas was examined but no abnormalities were found.

The patient's course following surgery was steadily retrogressive. The icterus and blood in the stools continued. The liver progressively increased in size. She developed fluid in the chest, and finally a frank empyema. She died on December 25, 1945, two months after admission.

The postmortem revealed a primary carcinoma of the papilla of Vater, involving the most distal portion of the common duct. No gross carcinoma in the lymph nodes about the head of the pancreas was found. There was considerable dilatation of the common and hepatic

ducts. The cystic duct was not dilated. There was distinct dilatation of the pancreatic duct. The pancreas proper was not indurated and was of normal size.

A third type of lesion which may resemble carcinoma of the duodenum is an area of invasion of the duodenal wall by a carcinoma of the head of the pancreas.

Carcinoma of the head of the pancreas characteristically produces symptoms of a painless, progressive jaundice. It is usually this jaundice that causes the patient to visit a physician. An early correct diagnosis is very difficult. When the lesion is localized and small, the only positive findings are the icterus, a distended gallbladder from common duct occlusion and light or clay-colored stools. If the lesion erodes the duodenal wall or duodenal mucosa, the stools may be positive for occult blood.

Although carcinoma of the head of the pancreas may produce an increase in the duodenal sweep, as it is seen when the gastrointestinal tract is examined roentgenographically with contrast media, this does not occur with early lesions. The tumor may invade the duodenal wall and destroy an area of duodenal mucosa. If the duodenal sweep is not increased and no distortion of the stomach is present, the roentgenologist may mistake the lesion destroying the duodenal mucosa for a primary carcinoma of the duodenum. However, if this lesion is small and situated away from the papilla of Vater, and the patient has a moderately severe icterus, the roentgenologist should consider the possibility of a lesion other than a primary carcinoma of the duodenum. It is unlikely that a small primary duodenal lesion away from the papilla would produce an icterus. Of course, we must state that early metastasis to the common duct from a primary duodenal carcinoma could occur and produce the above picture. The differential diagnosis between carcinoma of the head of the pancreas and primary carcinoma of the duodenum is of little but clinical interest, as either condition should be brought to surgery and the lesion resected if possible.<sup>8</sup>

Recently, we encountered a patient who

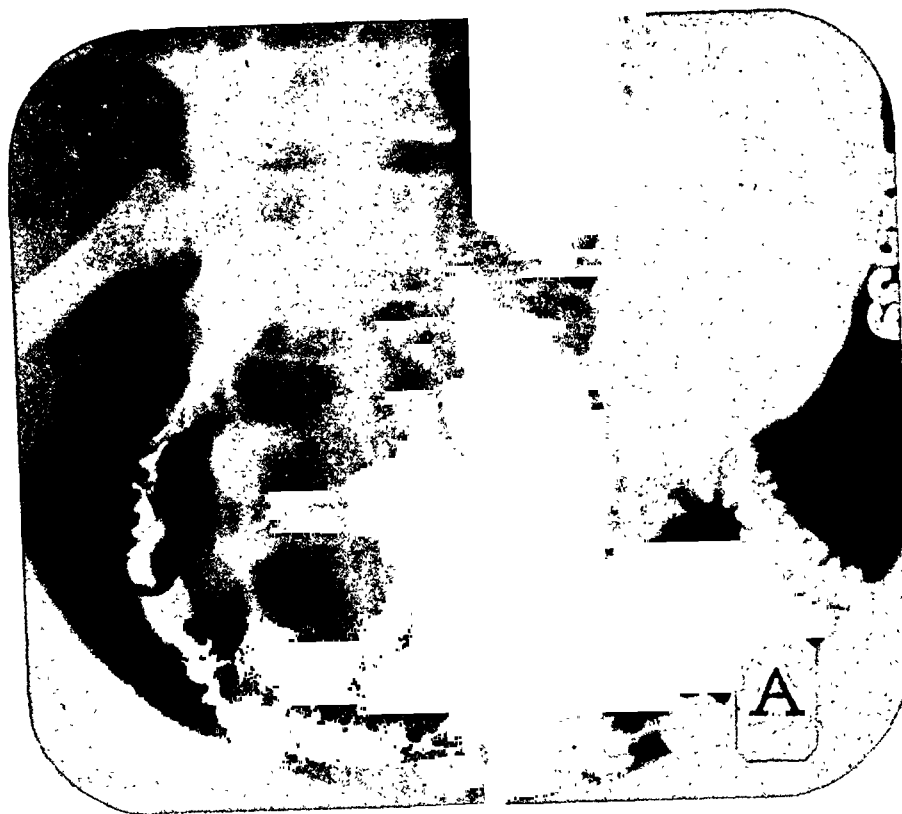


FIG. 6. *A*, this illustration is included to demonstrate the changes in the duodenal sweep which are described as typical for an expanding lesion of the pancreatic head. Note the increase in size of the duodenal loop and the flattening of mucosal folds without evidence of actual invasion. This was a case of a benign cyst of the head of the pancreas. *B* and *C*, Case IV. Prone and right anterior oblique views of the duodenum. The invasion of the inferomedial aspect of the junction of the first and second portions of the duodenum is well demonstrated. Note the absence of any enlargement of the duodenal sweep in spite of the huge mass of the tumor which could be palpated and which was found on surgical exploration.

had a lesion eroding the mucous membrane of the junction of the first and second portion of the duodenum. This lesion, at operation, proved to be a carcinoma of the head of the pancreas. A report of this case follows.

CASE IV. A white male, aged fifty-six, was admitted to the Buffalo General Hospital on February 2, 1946. He had been well until six months before admission when he noticed a throbbing sensation in his epigastrium. This sensation continued and gradually began to be accompanied by upper abdominal pain, not severe. He did not complain of nausea nor vomiting during this period.

About seven weeks before admission, the patient visited a physician. He was told that he had a mass in his stomach and he was advised to have a roentgenographic examination of his gastrointestinal tract. This was done at another department. No abnormalities were found.

About six weeks before admission, the patient began to have gastric distress after every meal. He also began to have epigastric distress and some aching or pain in the abdomen at night. In the two months before admission, the patient lost 20 pounds. There was no history of jaundice, light or dark stools, nor dark urine.

Examination on admission revealed a large orange-sized, irregular, movable, tender mass in the epigastrium, transmitting the aortic impulse. The liver and spleen were not palpable.

Urinalysis and blood count on admission were within normal limits. Serum amylase was 16 units and the plasma lipase was normal. Total protein determination was 6.6 mg. per cent.

Roentgenographic examination revealed an area of mucosal destruction involving the inferior portion of the first portion of the duodenum, extending slightly into the second portion with moderate associated filling defect. There was no evidence of any gross gastric or duodenal displacement. Our conclusion was a malignant process involving the junction of the first and second portions of the duodenum, most probably primary in the pancreas.

After proper preparation, the patient was operated upon on February 7, 1946. The pancreas was found involved in a malignant process which had extended into the wall of the transverse colon, metastasized to the regional aortic nodes, and to the liver. The duodenum was pushed well to the right by the mass. The veins of the greater omentum were markedly dis-

tended. It was impossible to remove this growth but a section was taken from the liver, the omentum and the growth in the pancreas.

The pathologist reported a medullary adenocarcinoma. The histopathologic picture pointed to a primary cancer of the pancreas. The biopsies from the omentum and liver showed the same picture. The patient made a good recovery from the operation and he was discharged on February 22, 1946. His condition was essentially unchanged.

Another lesion which, by extension, may resemble a primary carcinoma of the duodenum, is a primary carcinoma of the common bile duct.

This lesion, of course, produces signs of common duct obstruction very early. The patient has a distended gallbladder, pain, abdominal distress, and probably jaundice and light-colored stools. Occasionally, carcinoma of the common duct will invade the duodenal wall, particularly at the site where the duct passes under the first portion of the duodenum.<sup>5</sup> If the lesion erodes the duodenal mucosa, the roentgenologist may very easily mistake the erosion for a primary carcinoma of the duodenum. This is especially true if the lesion is on the posterior wall of the junction of the first and second portions of the duodenum, as a primary carcinoma of the duodenum in this area could produce the above symptoms and signs by direct extension to the common duct. However, carcinoma of the first portion of the duodenum is very rare. Even at surgery the operator might not be able to tell whether the lesion arose in the common duct and spread to the duodenum, or vice versa.

We have never had the opportunity in our department of demonstrating a lesion involving the duodenal mucosa arising from a carcinoma of the common duct.

As we have mentioned before, the purpose of diagnosing the lesions described above early in the course of the disease is to give the patient the advantage of surgery at a time when a cure is possible. Cattell,<sup>6</sup> Whipple and his associates,<sup>34,35,36</sup> Erb,<sup>13</sup> Hunt,<sup>20</sup> and others,<sup>26,28</sup> have shown that a

block dissection of the duodenum, common bile duct and the head of the pancreas, followed by a cholecystojejunostomy and gastrojejunostomy, will effect a cure of these lesions if distant metastases have not occurred.

### CONCLUSIONS

1. The roentgen findings in primary duodenal and paraduodenal malignant lesions have been presented.

2. The difficulties which are encountered in the differential diagnosis of these various lesions clinically, roentgenologically, surgically, and pathologically have been stressed.

3. The differential diagnosis between these various lesions is relatively unimportant and only of academic interest as the therapeutic approach is identical.

4. The importance of the correct roentgen diagnosis is to bring the patient to surgery while the lesion is still localized.

5. Illustrative cases have been presented to demonstrate the above points.

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# EXTRINSIC LESIONS AFFECTING THE RECTOSIGMOID\*

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THERE are many pathological processes arising in the pelvis exclusive of the large bowel which, because of their proximity or secondary involvement, produce defects in the rectosigmoid. This report deals with the appearance of bowel at the barium enema examination of such cases. The most notable example of a lesion which can produce extrinsic pressure on the rectosigmoid is endometriosis. This lesion, if untreated, may extend to the adjacent bowel where continued progression produces symptoms of intestinal obstruction in a manner similar to cancer in the same area. Likewise, other lesions arising especially in the uterus, tubes, and ovaries may produce the same sequence of events. In some cases, the deformity of the rectosigmoid is typical, whereas, in other instances, a differential diagnosis from cancer of the bowel is impossible. Clinically, the problem is significant in the proper evaluation of masses in the pelvis. The cases fall in the following groups:

1. Endometriosis
2. Carcinoma of the cervix with a frozen pelvis
3. Chronic inflammatory disease
4. Ovarian carcinoma and ovarian cysts
5. Effects of radiation therapy
6. Fibroid uterus
7. Sigmoiditis
8. Lymphosarcoma and metastatic carcinoma
9. Retroperitoneal tumors
10. Postoperative adhesions

## ENDOMETRIOSIS

Jenkinson and Brown<sup>20</sup>, in a recent article, state that "the importance of this disease as a cause of constricting lesions of the rectum and sigmoid has not been sufficiently stressed, nor is adequate roent-

genologic information available." A pre-operative diagnosis is important as the institution of conservative therapy will, in many instances, result in a subsidence of symptoms. Most clinics have become interested in endometriosis only after results of experiences described by Cattell,<sup>8</sup> where both the operative and preoperative diagnosis was carcinoma and the patient submitted to a two-stage abdominoperineal resection of the rectosigmoid and rectum and sigmoid.

*Pathology.* So much has been written in the past two decades concerning the pathologic characteristics of endometriosis that this description will merely pertain to the effect that it may have on the bowel. Endometriosis usually consists of ectopic endometrial tissue with histologic and functional characteristics similar to that of normal endometrium. The term adenomyosis is used to refer to the islands of endometrial tissue with myometrium. Implants usually occur on the serosal surface of the bowel with subsequent involvement of the muscular coats. The mucosa may be invaded which accounts for the occasional bleeding per rectum. An associated inflammatory reaction is always present. The combination of endometriosis with carcinoma is not common. The association of endometriosis with other pelvic disorders such as fibroid uterus and pelvic inflammatory disease is very common. This is important, as the distortion seen on the roentgenogram after the barium enema when endometriosis affects the bowel is different when it is associated with other pelvic pathology.

*Incidence.* Table 1, from Jenkinson and Brown,<sup>20</sup> illustrates the frequency of endometriosis affecting the rectosigmoid according to various authors:

\* From the Department of Radiology (Service of Dr. Marcy L. Sussman), Mount Sinai Hospital, New York.



TABLE I

	Series Total	Recto- sigmoid	Per Cent
Allen	112	41	37.0
Cattell	104	17	16.0
Counsellor and Masson	162	51	31.0
Keene and Kimbrough	118	6	5.0
Jenkinson and Brown	117	47	40.0
Total	613	162	26.0

For eighteen months every case of endometriosis admitted to Mount Sinai Hospital was subjected to a barium enema examination. Out of 140 cases of endometriosis, there were 6 cases that revealed defects in the rectosigmoid. Intestinal obstruction occurred once. Bowel symptoms were present in 4 cases. One hundred and twenty cases were subjected to laparotomy either because of the endometriosis or because of additional pelvic pathology. In 5 additional cases, implants of endometriosis were noted on the rectosigmoid during operation where the barium enema examination, except one (Fig. 7), was reported as entirely negative. In our series, therefore, about 10 per cent of the patients with endometriosis had lesions affecting the rectosigmoid. The reason for the difference of the figures by the different authors is probably due to the fact that the colonic lesion may consist of a single implant, and theoretically, this is endometriosis of the bowel. However, from a clinical point of view, these lesions are insignificant. Table II discusses endometriosis which causes sufficient symptoms referable to the large bowel as to be of some discomfort to the patient. When this is considered, the actual incidence is much lower. It is true, however, that very often bowel symptomatology is overlooked or becomes subordinate to the other symptoms of endometriosis.

*Roentgen Characteristics.* Josefsson<sup>21</sup> in 1939 described a case which he called strangulating endometriosis of the sigmoid colon. He felt that the roentgenological signs which were present were fairly char-

acteristic and described them as follows: "A well-circumscribed stenosis of the intestinal lumen with an intact mucous membrane. The bowel close to the constricted lesion presents only a picture of mild colitis. Some of the folds of the mucous membrane at the site of the stenosis are prickly and irregular."

He stresses the importance of roentgenologic examination during menstruation and during the interval to demonstrate changes in the constricting lesion.

Two factors probably produce the roentgen findings: first, the endometrial tumor; and second, the inflammatory reaction. Most authors believe that the latter is the basis for roentgenologic findings in that the inflammatory reaction may result in fibrosis and cicatricial contracture of the bowel. It should be noted, however, that very often after castration the bowel wall returns to normal, indicating that the degree of fibrosis cannot be very marked. The presence of roentgenologic signs also depends somewhat on the extent of the bowel involvement and the location of the lesion. Jenkinson and Brown<sup>20</sup> state that implants on portions of the bowel which are freely suspended by a mesentery are less likely to show constricting lesions than are portions of the bowel which are partly extraperitoneal and more firmly attached. We have divided endometriosis roentgenologically into four types according as it produces:

1. Slight irritability of the bowel
2. A characteristic pressure defect
3. A lesion which can be confused with carcinoma, and
4. Complete obstruction of the bowel.

TABLE II\*

	Obstructive Symptoms	Recto- sigmoid Lesions
Cattell	12	17
Mayo	15	38
Jenkinson	21	47
Present Series	4	11

\* From Jenkinson and Brown.<sup>20</sup>

Type 1: Small implantations cause slight irritability and tenderness of the bowel as secondary inflammatory reaction from the implant is not unusual. However, this type of irritability is not usually sufficiently characteristic to differentiate it from other inflammatory processes. They are usually found at operation and rarely during the roentgen examination (Fig. 1).

Type 2: The characteristic lesion is usually a relatively long area of constriction varying from 4 to 10 cm., intact mucous membrane, and an indefinite line of demarcation between normal and pathological portions of bowel. The folds of mucous membrane at the site of the stenosis may be distorted and the haustral markings point in several directions (Fig. 2). This is due to the perisigmoidal inflammation and fibrosis. Ulceration of the mucous membrane occurs rarely. The fixation of the bowel is quite characteristic and is best seen roentgenoscopically, where it can be noted that the bowel has lost its mobility, and appears to be fixed in a bed of fibrous tissue. If all the organs of the pelvis are imbedded in a mass of endometrial tissue which has undergone secondary inflammatory change and fibrosis, the segment of bowel will be fixed and spasm which is usually observed in the



FIG. 2. Area of constriction involving rectosigmoid. Folds of mucous membrane at the site of stenosis distorted but intact. Haustral markings pointing in several directions. Findings at operation: endometriosis of bowel.

constricted area may be absent, since the bowel does not react to the inflammatory change. This also occurs if there is an associated fibroid uterus (Fig. 3) or pyosalpinx which becomes adherent to the rectosigmoid. When the examination is done during the menstrual period, there may be an exaggeration of all the above findings.

Type 3: Adenomyosis when it affects the rectosigmoid is isolated to a very small segment which can readily be confused with a short, stenotic scirrhus carcinoma in the same area. The constricted lesion is small and an adequate study of the mucosa cannot be made. Also because of the infiltration of the adenomyotic tissues, overhanging edges at the margins of the lesion, as is noted in carcinoma, is seen. Fortunately it is uncommon, as this type of lesion may be confused with carcinoma by the surgeon at the operating table.



FIG. 1. Indentations along upper lateral surface of rectum and rectosigmoid due to small endometrial implants.



FIG. 3. Constricted segment of bowel, fixed intact mucous membrane, pointed haustral markings not seen. Findings at operation: large fibroid uterus with considerable endometriosis.

Type 4: Endometriosis causing complete intestinal obstruction cannot be differentiated from any other process producing obstruction.

#### FIBROID UTERUS AND OVARIAN CYSTS

It is unusual for compression of the sigmoid by a smooth mass such as a fibroid uterus or ovarian cyst to produce enough constriction to cause gastrointestinal symptoms. For this reason, barium enema examination is rarely performed. To study the type of defect encountered, 15 patients with large fibroid uterus and ovarian cysts were subjected to barium enema examination. Also 30 cases of this type of compression of the sigmoid were collected in which the barium enema examination was done for other reasons. The sigmoid being relatively mobile was compressed, but not constricted. When there is no inflammatory process present to fix the bowel, it remains mobile and distensible. This probably accounts for the lack of intestinal symptoms in these cases.

*Roentgen Findings.* The area of compression which depends on the size of the mass is smooth and merges gradually with normal bowel. The mucous membrane remains intact and the folds assume a longi-

tudinal direction because the bowel is stretched at this point (Fig. 4). This type of defect has been produced experimentally by Schatzki and Hawes,<sup>28</sup> in the esophagus, where instead of abruptly angled corners such as seen in submucosal tumors (leiomyosarcomas) or attached extrinsic tumors, there is a gentle slope which starts within the uninvolved area a short distance from the actual edge of the compressing tumor, and extends to the most protruding part of the tumor (Fig. 12). This finding can be produced by any movable, non-adherent mass in the pelvis such as a fibroid uterus or ovarian cyst. When pelvic inflammatory disease intervenes, or endometriosis, the mass may become adherent to the bowel wall which then takes on the roentgen appearance of an attached extrinsic lesion. Figure 12, from Schatzki and Hawes,<sup>28</sup> illustrates the difference in appearance between unattached extrinsic tumors and attached extrinsic tumors.

#### CARCINOMA OF THE OVARY

It is not unusual for carcinoma of the ovary to invade the rectosigmoid and produce intestinal obstruction. When there is



FIG. 4. Smooth, compressed area involving rectosigmoid. Intact mucous membrane assuming a longitudinal direction. Bowel mobile. Findings at operation: large ovarian cyst. (Folds retouched.)

complete obstruction, it is impossible to differentiate this lesion from other causes. However, in cases where there is constriction without complete obstruction, two types of lesion are observed: (1) A long, stenotic filling defect with scalloped edges not unlike that produced in metastatic implants elsewhere. The mucous membrane may be intact or destroyed from the outside (Fig. 8). Occasionally the stenosis that is produced may be quite long and irregular, almost simulating the stenosis seen in lymphogranuloma venereum. (2) A small



FIG. 5. Scalloped filling defect of sigmoid with evidence of a mass. Mucous membrane destroyed on medial aspect. Operation: sigmoid carcinoma. This type of defect is also seen in carcinoma of the ovary, with spread to adjacent bowel.

scalloped filling defect with or without destruction of the mucous membrane. Differentiation of this type from a small polypoid carcinoma of the sigmoid may be difficult or impossible. Figure 5 illustrates a polypoid carcinoma of the sigmoid which was thought to be due to extrinsic pressure from a carcinoma of the ovary. As a general rule, mucosal lesions reveal more ulceration of the mucous membrane than extramucosal lesions. Also extramucosal tumors are often demonstrable as large soft tissue masses outside the barium column.

#### CARCINOMA OF THE CERVIX UTERI

Advanced cases of carcinoma of the cervix may involve the rectosigmoid where

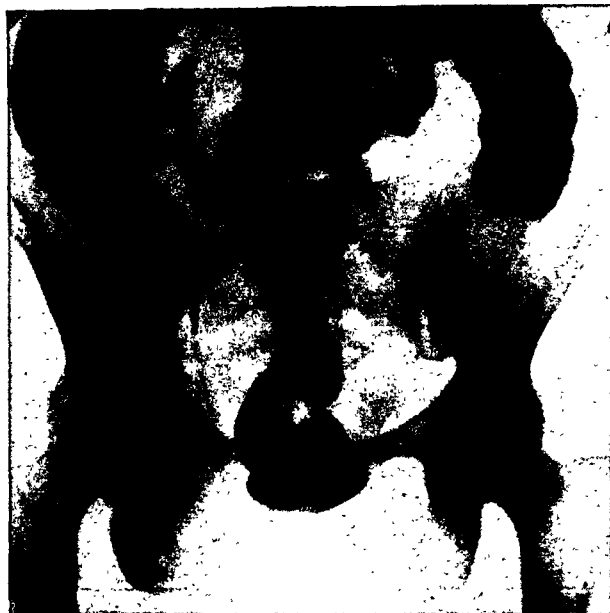


FIG. 6. Smooth, long, compressed area, fixed intact mucous membrane, not distensible. Findings: carcinoma of the cervix.

it usually causes a smooth, long, compressed area with intact mucous membrane (Fig. 6). Roentgenoscopically, the constricted area is fixed, not distensible, and not tender. These findings are not pathog-



FIG. 7. Long, constricted area, evidence of a mass, sharp lower margin, intact mucous membrane. Findings: retroperitoneal sarcoma.

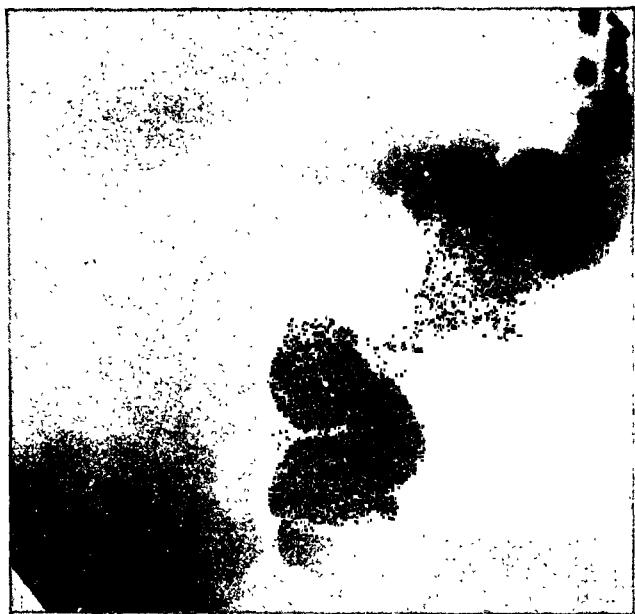


FIG. 8. Stenotic, elongated segment, scalloped margins, destroyed mucous membrane. Findings: metastatic carcinoma of bowel from ovary.

nomonic and have been observed with retroperitoneal sarcomas (Fig. 7) when a fibroid uterus is associated with endometriosis or with pelvic inflammatory disease (Fig. 3). Nodular, irregular, scalloped defects such as seen in carcinoma of the ovary or metastatic implants with extension to the rectosigmoid is not observed (Fig. 8). We have not seen carcinoma of the uterus or of the tubes with metastasis to the pelvis compress the sigmoid.

#### RETROPERITONEAL SARCOMA

These tumors are usually quite large, smooth, or slightly lobulated. They become attached to the bowel wall, but rarely invade the mucosa. The margins of the lesion are usually sharp in contradistinction to the gentle sloping seen with a fibroid uterus. A mass can often be visualized (Fig. 7). The roentgen characteristics are the same as those seen in a fibroid uterus with pelvic inflammatory disease or any attached extrinsic lesion. In these cases, although the area of attachment to the bowel is usually much smaller than the pelvic mass, it is still quite large.

#### METASTATIC CARCINOMA (PELVIS)

The typical roentgen appearance is that of a stenotic segment, quite long, and with

scalloped margins that do not conform to any particular pattern. The mucous membrane may be destroyed (Fig. 8). The edges of the lesion occasionally may overhang such as seen in intrinsic carcinoma. However, more typically, they are angulated outwardly and sharp. Occasionally, when the segment involved is short, differential diagnosis from an intrinsic polypoid lesion or carcinoma of the ovary with extension to the rectosigmoid is impossible (Fig. 5).

#### RADIATION INJURY TO THE BOWEL

In the differential diagnosis of extrinsic lesions of the rectosigmoid, it is necessary to include cases of intestinal injury after radium and roentgen treatment of various pelvic organs. This is usually of two types: (1) Part of a general destructive process involving all the pelvic organs and the body surface. (2) Limited to a small segment of bowel. This is more frequent because modern technique has made it possible to administer a dose just sufficient to injure the intestinal mucosa without affecting the other intestinal walls to any large extent.

*Pathology.* Experimentally, the susceptibility of intestinal mucosa to roentgen radiation has long been known. This has been reviewed fully by Desjardins,<sup>14</sup> and others.<sup>10,23,31,32</sup> There first appears a spastic contraction of the intestine followed by infiltration with polymorphonuclear leukocytes and then early degenerative changes. There proceeds a degeneration of the elements of the mucosa followed by ulceration. The muscularis is affected only by large doses. Repair may be complete without cicatrization, but usually there is slough with scar formation and stricture. Therefore, the pathology varies from mild inflammation through various stages of destruction and possibly perforation. There is repair with varying degrees of stenosis and atrophy.

*Roentgen Aspects.* In the reported cases, 60 per cent of the patients who have intestinal symptoms following radiation therapy show some distortion of the barium enema examination. Corscaden, Kasabach and



FIG. 9. Area of constriction involving sigmoid. Serrated margins, distortion of the mucosal folds, varying degree of stricture of the lumen, spasm. Findings: due to post-irradiation injury. (Reproduced by permission from Corscaden, Kasabach and Lenz.<sup>11</sup>)

Lenz<sup>11</sup> reported that 21 out of 35 cases with intestinal symptoms showed a demonstrable change in the contour and mucosal pattern of the affected segment. In their series of cases, the sigmoid was by far the most common location of post-irradiation injury. The cases can be divided into three groups:

1. Localized spasm with little or no exaggeration of the mucosal folds or serration of the serosal border.
2. Spasm, serrated margins, exaggeration and distortion of the mucosal folds and a varying degree of stricture of the lumen. Roentgenoscopically, the distensibility of the lumen will vary. There is usually not a sharp demarcation of the pathologic lesion but it merges gradually with normal bowel (Fig. 9).
3. Annular constriction with marked intestinal obstruction. This may be due to intrinsic fibrosis of the muscularis or to cicatricial contraction of the extrinsic parametrial tissue.

Massive destruction and fistula formation has been described by Kleine.<sup>23</sup> These are usually accompanied by other injuries

from irradiation and are quickly followed by toxemia and death. Barium enema examinations of such patients are few and are so rarely encountered that discussion will be limited to mild injuries described above.

Spasm and serrated margins are the two most important findings encountered in the roentgenological examination. The serrated margins which are due to the degeneration and ulceration of the intestinal mucosa are found practically always in these lesions. Roentgenoscopically, it can be noted that the bowel varies in its distensibility due to the fact that the muscularis is rarely affected. There is never a clean-cut demarcation between involved and uninvolved segments of bowel as the adjacent bowel usually exhibits some degree of spasm. The edema which so often accompanies this lesion may cause marked exaggeration of the mucosal folds which can almost mimic the filling defects which are seen in lymphosarcoma or in the polypoid type of carcinoma. The extent of involvement varies from 3 to 8 cm. The lesion is primarily in its initial stages an inflammatory process of the mucosa similar to ulcerative colitis in its segmental form except that it is more



FIG. 10. Area of constriction with intact mucous membrane, no overhanging margins as seen in carcinoma. Findings at operation: pelvic inflammatory disease.

severe and accompanied by a good deal of spasm. The spasm has been ascribed to the direct action of the roentgen radiation in addition to the inflammatory process.

#### PELVIC INFLAMMATORY DISEASE

It is uncommon for pelvic inflammatory disease to affect the lumen of the rectosigmoid sufficiently to produce symptoms of intestinal obstruction. The inflammatory process may cause spasm and irritability in this portion of the bowel; however, these findings are transitory and are seen in many different conditions. Also in patients with a frozen pelvis and extensive inflammatory disease, the incidence of symptoms of partial intestinal obstruction is quite low. There are cases, however, which are seen from time to time where the pelvic inflammation causes sufficient obstruction of the rectosigmoid so that an intrinsic lesion of the bowel is simulated.

*Pathology.* The inflammatory reaction in the pelvis and the ensuing fibrosis which affects the perisigmoidal tissues is usually mild and accounts for the lack of marked spasm or distortion of the mucous membrane pattern on the barium enema examination. This differs from endometriosis where, due to the severe inflammatory reaction and fibrosis, spasm and distortion

of the mucous membrane pattern are usually present. Most of the constriction of the rectosigmoid in pelvic inflammatory disease is due to adhesions between tube and ovary and bowel.

*Roentgen Findings.* Five cases form the basis of the following observations: There is an area of constriction, usually in the rectosigmoid, varying in length between 4 and 8 cm. The edges of the constricted area merge gradually with normal bowel and no overhanging margins are observed. There is no distortion of the mucous membrane, which is intact. There is usually involvement of both sides of the bowel and no areas of spasm are noted. Roentgenoscopically, there is some mobility of the involved bowel (Fig. 10 and 11).

#### SIGMOIDITIS

There is a type of intestinal obstruction which is occasionally observed which has been described by some authors as due to spasm and by others as due to a nonspecific inflammation of the bowel wall. A typical history is that of acute intestinal obstruction, and the barium enema examination reveals a complete, smooth obstruction usually in the rectosigmoid or some other part of the bowel. In most cases, when the barium enema examination is repeated in a few hours, the obstruction is no longer present. These cases, although called sig-



FIG. 11. Long area of constriction simulating lymphogranuloma venereum due to pelvic inflammatory disease.

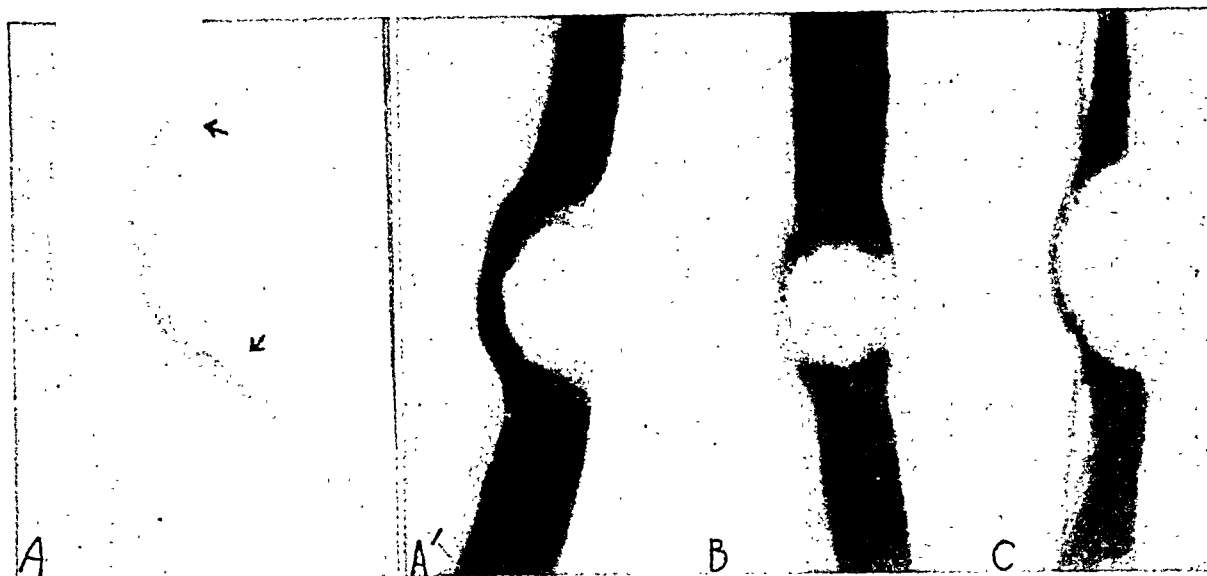


FIG. 12. *A*, extrinsic tumor not attached to the esophagus. In the lateral view there are gentle slopes at the edge of the tumor. *A'*, *B* and *C* illustrate the appearance of a tumor completely attached to the esophagus. It also assumes the characteristics of an intrinsic lesion. Compare with *A*. (Reproduced by permission from Schatzki and Hawes.<sup>28</sup>)

moiditis, are most likely due to spasm rather than an inflammatory process which plays an insignificant role. Fourteen cases have been observed at Mount Sinai Hospital and in only 2 cases was pelvic pathology present.

#### POSTOPERATIVE ADHESIONS

It is not common to perform a barium enema examination on these cases. The few cases that have come to our attention have revealed the following: Either a complete obstruction, or a partial obstruction where it is possible to pass barium beyond the lesion. The mucous membrane is always intact. The area of constriction is short, smooth, and appears as a fusiform narrowing. Both sides of the bowel are usually constricted.

#### DIFFERENTIAL DIAGNOSIS

In order to simplify differential diagnosis, the above cases have been divided into two groups, according to whether the extrinsic pressure is due to:

1. Inflammatory reaction, or
2. Tumor masses (benign or malignant).

Group 1 includes endometriosis, pelvic inflammatory disease, radiation injury to

the bowel, and carcinoma of the cervix.

Group 2 includes fibroid uterus, ovarian cysts, carcinoma of the ovary, and carcinoma metastatic to the pelvis.

The roentgen signs of the lesions in Group 1 are fairly typical and differentiation from one another is usually not difficult. They can, however, be confused with the following intrinsic lesions involving the rectosigmoid:

*1. Carcinoma.* The short, constant filling defect, sharp overhanging, irregular margins, and ragged moth-eaten mucosa observed in carcinoma of the bowel are rarely seen in pelvic inflammatory disease, radiation injury, and carcinoma of the cervix. Endometriosis, however, when the mucous membrane is distorted, the demarcation of the involved area sharp, and the constricted segment constant, may resemble carcinoma of the bowel. In many cases, an adequate study of the mucous membrane pattern is difficult as the area of involvement may be small and whether the mucosa is intact or destroyed cannot be demonstrated. When sufficient bowel is involved, as is usually the case in endometriosis (8 to 10 cm.), little difficulty is encountered in obtaining an adequate mucous membrane



study and the areas of spasm and the sharply pointed haustral markings going in several directions which occur so frequently in endometriosis, are more easily identified.

It should be noted that there is a type of radiation injury where the haustral markings become so edematous that the filling defect produced mimics a polypoid type of carcinoma or a lymphosarcoma.

2. *Diverticulitis*. Differential diagnosis of diverticulitis from endometriosis and pelvic inflammatory disease may, at times, be difficult since in all three lesions the mucous membrane may be intact or only slightly distorted, the edges of the lesion sharp or gradually merging with intact bowel, and areas of spasm absent. In the prefibrotic stage of diverticulitis, the accordion-like, regular, spike-like projections are characteristic. Although areas of spasm are noted in endometriosis they are farther apart and have no regular pattern. Roentgenoscopically, in endometriosis the fixation of the bowel is quite notable whereas in diverticulitis and pelvic inflammatory disease, there may be some mobility. This is especially true in diverticulitis, where there may be relatively little reaction in the pelvic tissues.

3. *Lymphogranuloma Venereum*. Four groups of lymphogranuloma venereum have been described from a roentgen standpoint: (a) narrowing of the rectum and rectosigmoid with slight ulceration of the mucosa best seen on the evacuation roentgenogram. This type is indistinguishable from an early ulcerative colitis and proctitis; (b) marked narrowing of the anorectal region; (c) irregular tubular or conical, diffuse, shaggy-appearing constrictions with fine ulcerative margins. This appearance was seen in 74 per cent of the cases in Helper and Szilagyi's<sup>19</sup> series. Fistulous tracts are frequent; (d) late cases similar to that just described with strictures measuring from 6 to 15 cm. but without fistulous tracts. The mucous membrane pattern may be normal due to the healing of the mucosal ulcerations.

Radiation injury will occasionally mimic

group (a). However, lymphogranuloma venereum rarely attacks the sigmoid without involving the rectum, and the fibrosis in the latter area is so intense that constriction of the lumen is an early finding. There is no difficulty in distinguishing the other three types from radiation injury. Isolated cases of lymphogranuloma venereum affecting only the rectosigmoid have been reported, but this is extremely unusual.<sup>26</sup> Carcinoma of the cervix may simulate (d) where a long segment of bowel may be constricted and the mucous membrane remains intact. However, carcinoma of the cervix with a frozen pelvis usually involves rectosigmoid without rectum.

4. *Ulcerative Colitis*. In early lesions where mucosal ulcerations are present it may be impossible to differentiate between radiation injury, lymphogranuloma venereum, or ulcerative colitis. Usually however, spasm which is such a prominent feature in radiation injury is not observed in ulcerative colitis. Tuberculous colitis,<sup>27</sup> involving only sigmoid is rare and usually forms large ulcerations which is easily distinguished from the fine serrations seen on the barium enema examination in intestinal injury. In most cases of amebiasis involving the sigmoid, there will be involvement of the cecum which becomes irregularly narrowed, at times resembling a cone and at other times a very small pouch. Cases, however, have been reported involving isolated segments of the bowel without involvement of the cecum. Again the spasm and serrated margins described in radiation injury are not seen.

Group 2. This group comprises those lesions which deform the rectosigmoid because of the presence of a mass. These are of two types: (1) those that compress the rectosigmoid without being attached to the bowel wall, and (2) those which attach themselves intimately to the serosa.

Extrinsic unattached lesions are characterized by a gradual indentation which starts within the uninvolved area a short distance away from the actual edges of the compressing tumor and extends to the most

protruding part of the tumor. The mucous membrane always remains intact. This is seen in the sigmoid when a fibroid uterus or ovarian cyst compresses this portion of the bowel. Attached extrinsic lesions produce sharply defined, straight edges between uninvolved and involved bowel, and when seen in profile only one side of the bowel is invaded. The same type of filling defect is seen experimentally in mucosal tumors and submucosal lesions such as leiomyosarcomas. This has been described by Schatzki and Hawes<sup>28</sup> in the esophagus.

Clinically, there are differences. Mucosal lesions are always ulcerated. Attached benign extrinsic lesions do not cause ulceration of the mucosa. Extrinsic malignant lesions such as ovarian carcinoma may ulcerate the mucosa and then differentiation from an intrinsic carcinoma involving only one wall of the sigmoid is impossible. Figure 5 illustrates this point. On pelvic examination, this patient had a mass on the left side. Barium enema examination revealed a single scalloped filling defect with destruction of some of the mucous membrane. Because of the pelvic mass, a carcinoma of the ovary with infiltration into the bowel was considered. A polypoid carcinoma of the rectosigmoid could not be excluded. At operation, an intrinsic carcinoma of the bowel, plus a fibroid uterus, was found.

Occasionally normal mucosal folds are visible in mucosal as well as in extramucosal lesions. In both instances, they are the folds of the wall opposite the tumor and not the folds running across the lesion. Tumors in the pelvis which attach themselves to the sigmoid are quite large and a much greater area of constriction is noted than is observed in an intrinsic process. Very often the mass can be visualized on roentgen examination. Mucosal tumors very rarely have an extrinsic visible soft tissue mass.

#### COMMENT

An attempt has been made to present the roentgen characteristics of extrinsic lesions

affecting the rectosigmoid without considering the clinical history and pelvic examination. Very often the clinician, when the history is insufficient, has only to rely in the differentiating of pelvic masses on what has been called "the tactus cruditus" of the examining finger. Also, 3 cases have recently been explored for a carcinoma of the bowel where an extrinsic lesion was found. Similar occurrences are not uncommon in other hospitals. It can readily be seen, therefore, that a proper evaluation of the barium enema examination and its pitfalls can be very helpful especially when the attending lesion is not within the reach of the sigmoidoscope.

#### CONCLUSIONS

1. Compression of the rectosigmoid by extrinsic masses is not uncommon.
2. This compression may simulate the defect of an intrinsic neoplasm.
3. The roentgen characteristics of extrinsic lesions affecting the rectosigmoid are considered, especially as to their differential diagnosis from carcinoma of the bowel.

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# SIGMOIDOVESICAL FISTULA

## A REVIEW OF THE LITERATURE AND REPORT OF A CASE DEMONSTRATED BY BARIUM ENEMA\*

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**S**IGMOIDOVESICAL fistulas are not uncommon surgical problems. They occur much less frequently in women than in men. This is due in part to the low incidence of diverticulitis in women. Furthermore the uterus is a protective barrier in intercommunications between colon and bladder. The fistulous tract is seldom demonstrated by roentgen methods. The purpose of this paper is to report a case of sigmoidovesical fistula in a woman with diverticulitis, which was demonstrated by barium enema.

### TERMINOLOGY

Barnes and Hill<sup>8</sup> believe that fistulas between the intestinal tract and the bladder should be spoken of as "intestinovesical" fistulas instead of the more commonly used term "vesico-intestinal" fistulas, since in practically all cases the fistula is primary in the intestine and not in the bladder. Thus, correspondingly, other terms as "ileovesical," "appendicovesical," "colovesical," "sigmoidovesical," and "rectovesical," would be used.

### ETIOLOGY

Diverticulitis is the most common cause of sigmoidovesical fistulas. In a series of 88 cases described by Mayo and Miller<sup>1</sup>, which included 54 cases of their own, and 34 of Sutton's, 38 were caused by diverticulitis. Kellogg<sup>4</sup> reported that 42 per cent of his intestinovesical fistulas were due to diverticulitis. He listed as other causes of the fistulas, carcinoma 18 per cent, operative trauma 11.3 per cent, appendicitis 5.6 per cent, congenital 3.4 per cent, and external trauma 2.2 per cent. Ewell and Jackson<sup>7</sup> reported 40 per cent diverticulitis in a

similar series, and described 1 case in which the fistula arose from carcinoma in a diverticulum.

The less common causes of sigmoidovesical fistulas include carcinoma, inflammations other than diverticulitis, trauma from surgery, trauma from gunshot wounds, and in a few cases, pathological conditions arising primarily in the bladder. Sigmoidovesical fistulas in children are practically always congenital, and are associated with anal anomalies.

### INCIDENCE

The majority of cases occur in men in the fifty to sixty year age group. The lower incidence in women is explained on the basis of two factors: (1) Diverticulitis, the most common cause of the fistulas, is less frequent in women than in men. (2) The uterus lies between the sigmoid and the bladder and thus prevents the formation of a fistulous tract.

### SYMPTOMS

In those cases of sigmoidovesical fistulas due to diverticula, the patient's history can usually be divided into two phases: i.e., the symptoms caused by the diverticulitis, and those due to the actual perforation and fistulous tract formation. Repeated attacks of generalized abdominal cramps, pain in the left lower quadrant, blood, mucus and pus in the stools over a number of months or years, are common findings. With perforation, and the introduction of gas and feces into the bladder, cystitis invariably develops, and with it comes urgency and frequency of urination, the passage of foul-smelling urine, chills and fever. Feces and gas are passed per

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urethra. At times, there is an ascending infection into the ureters and kidneys, with additional symptoms referable to these parts. In some cases, instead of the passage of the colon contents into the bladder, the reverse takes place, and urine passes into the colon, and eventually out through the rectum.

#### DIAGNOSIS

The diagnosis of a sigmoidovesical fistula can usually be made from the patient's history alone. The cardinal findings are pneumaturia, the passage of feces through the urethra, or the passage of urine through the rectum. Any one of these usually clinches the diagnosis. One possible exception to this is the occasional diabetic who has a pneumaturia caused by bacterial action on the urine sugar. Palpation of the abdomen or rectal examination often reveals a tender mass in the left lower quadrant.

Cystoscopic examination is invaluable as a diagnostic aid. In most instances, the site of the fistulous opening can be determined. In Higgins's<sup>6</sup> series of 40 cases of intestinovesical fistulas, he found the opening to be in the region of the trigone (left wall) in 24, the posterior wall behind the trigone in 4, near the internal sphincter on the floor of the bladder in 4, the right posterior wall in 3, the right lateral wall in 2, and undetermined in 3. In Mayo and Miller's<sup>1</sup> series of 54 cases of sigmoidovesical fistulas, 30 were cystoscoped, and 13 fistulas openings were seen. Barnes and Hill<sup>8</sup> state that rarely can the actual opening be seen because of the area of acute inflammation and edema which surrounds it. Severe cystitis is a common finding.

Some authors advocate the injection of methylene blue into the bladder with a subsequent search for it in the rectal contents. Proctoscopic examination in sigmoidovesical fistulas is usually not of significant help.

#### ROENTGEN EXAMINATION

Roentgen rays may be used in two ways:  
(1) Cystograms outline the bladder wall

but rarely demonstrate the fistulous tract. Ten of Mayo and Miller's<sup>1</sup> 54 cases had cystograms, but only 1 of these showed the tract. Barnes and Hill<sup>8</sup> show a cystogram with leakage of fluid into the large bowel. (2) The barium enema has given equally disappointing results. Higgins<sup>6</sup> states that "the barium enema has failed to give visualization of the fistulous tract in every case in which it was employed." Mayo and Miller<sup>1</sup> state: "Although the roentgenogram was valuable in demonstrating the regional extent of the diverticulitis, the fistulous tract was demonstrated on only one occasion." Barnes and Hill<sup>8</sup> used the barium enema in 6 of 14 cases, and no tracts were visualized. Oldham,<sup>5</sup> on the other hand, published a case report and a roentgenogram of a sigmoidovesical fistula in the British literature in which the barium enema fluid filled not only the bladder, but also flowed into the right ureter and right kidney pelvis, demonstrating a hydro-nephrosis.

#### CASE REPORT

C. T., an Italian female, aged sixty-three, was first seen in the Vanderbilt Clinic in May, 1940, at which time her complaints were epigastric pain and vomiting of several years' duration. Eight years previous to this she had been confined to bed for two weeks with "intestinal grippe," and since then she has had swelling of her legs in the mornings, constipation, left lower quadrant tenderness, and left back pain. The pain was relieved often by enemas and ice bags.

Physical examination in 1940 showed that she was a short obese Italian female of sixty-three not appearing acutely ill. Her blood pressure was 150/85 and her pulse was 80. On examination of the abdomen, a hard, non-fluctuant, slightly tender mass was felt in the left lower quadrant. Its lower border could not be definitely discerned. There was tenderness on deep palpation to the left of the mass. Numerous varices were present in the legs. Pelvic and rectal examinations were essentially negative. The impression was ovarian cyst.

A blood count showed hemoglobin 13.5 gm., red blood cells 4.71 million, white blood cells 7,500, with 65 per cent polymorphonuclears, 26 per cent small lymphocytes, 5 per cent large

lymphocytes, 3 per cent monocytes and 1 per cent eosinophiles. Urine examination showed a 1 plus albumin, and rare red blood cells.

A consultation revealed no evidence of gynecological pathology.

Examination after barium enema showed multiple diverticula of the descending colon and sigmoid, together with evidence of irritability and tenderness which indicated the presence of diverticulitis to the examiner.

The patient was placed on a bland diet and showed considerable improvement. In August, 1940, a deep varicose ulcer of the right leg was treated at the clinic.

She was not seen in the clinic again until December, 1944, at which time she complained of cough, vomiting, epigastric pain, and pale stools. An upper gastrointestinal examination was negative, and a gallbladder series showed a normal response. She was put on a diet once again, and she improved.

On March 1, 1946, the patient was admitted to Presbyterian Hospital with the history that in July, 1945, she began to have recurrent episodes of chills, and fever as high as  $104^{\circ}$  F., associated with generalized abdominal cramping pains, and frequency of urination. Five days before admission, she developed severe suprapubic and low back pain, which was associated with the passage of dark brown "fecal-like" foul smelling urine and blood clots. She had taken a



FIG. 1. Sigmoidovesical fistula. The left half of the colon, the rectum, and the bladder are filled with barium solution, which was introduced through the distal arm of the transverse colostomy.



FIG. 2. A left posterior oblique view of the barium-filled sigmoid, rectum and bladder. A portion of the fistulous tract originating in the mid-sigmoid can be seen filled with barium.

colon lavage prior to the onset of her pain. Physical examination at that time revealed an ill-defined left lower quadrant mass which was tender on palpation. There was no rebound tenderness. The spine was tender across the body of the sacrum. Rectal examination revealed a mass projecting on the right anterior rectal wall, which was tender on palpation. Surgical consultation suggested a sigmoidovesical fistula. On March 2, the day following admission, a transverse colostomy was done. The surgeon manually explored the lower abdomen, and a huge abscess, presumably caused by a ruptured diverticulum, was found. No operative procedures were done other than bringing out a loop of transverse colon. This was opened several days later. Ten days after operation, a cystoscopic examination of the bladder failed to disclose a fistulous opening. Twenty-three days after operation, a barium enema was given through the distal loop of the transverse colostomy (Fig. 1 and 2). The barium passed through the left half of the colon and into the rectum without encountering obstruction. At the same time that it entered the sigmoid and rectum, some of it passed into the bladder from the colon through a fistulous tract originating in the mid-portion of the sigmoid. Numerous diverticula were seen. Following the patient's return to the ward from the Roentgen Department, the bladder was irrigated, and no deleterious results from the barium filling were noted. On April 1, she was discharged to her home for six weeks, at the end of which time

she was to be readmitted for further operative procedure.

She was readmitted on May 13, feeling much better physically. She had gained 4 pounds, and had no urgency or frequency of urination. Blood and urine examination were not significant. A second barium enema via the distal loop of the colostomy again filled the bladder and demonstrated the fistulous tract. A cystoscopic examination revealed a slight puckering of the mucosa in the dome of the bladder. On May 23, she was taken to the operating room where an exploratory celiotomy was done. The fistula from the sigmoid to the bladder was demonstrated. This connection was severed and removed, and the patient was returned to the ward in good condition. Recovery was uneventful.

In June she again showed signs of a severe cystitis. Methylene blue injected into the distal loop of the colostomy was recovered in the urine which was evidence that the tract had reformed. She was discharged without further surgery and has been followed in the clinic. Her course remains the same.

#### SUMMARY

1. The literature on the subject of sigmoidovesical fistulas is reviewed.
2. A case of sigmoidovesical fistula in a

woman with diverticulitis in which the fistulous tract was demonstrated on barium enema examination is reported.

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# CALCIFIED APPENDICEAL FECAL CONCRETIONS IN CHILDHOOD

## A REPORT OF EIGHT CASES

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ACCORDING to Boyd<sup>3</sup> fecal concretions in the appendix are very common. He states that they vary greatly in consistence and are sometimes as hard as stone. They may be laminated like gallstones. Stenosis of the proximal end of the tube favors their formation. These concretions were formerly mistaken for the stones of fruit. Bailey and Love<sup>2</sup> also mention the fact that fecal concretions have a laminated structure. They say that "they are composed of inspissated fecal material, calcium and magnesium phosphates and carbonates, bacteria and epithelial debris; rarely a foreign body is incorporated in the mass." Very often perforation of the obstructed appendix results, particularly at the site where a concretion has impacted.

Metallic foreign bodies such as shot in the appendix are fairly frequently diagnosed by the roentgen ray, particularly in regions where wild game is eaten but calcified appendiceal fecal concretions are less often recognized. The common soft fecaliths can only be shown as filling defects in the barium-filled appendix. Golden<sup>10</sup> states that fecal concretions in the appendix which contain enough calcium to cast a recognizable shadow on a roentgenogram must be quite uncommon in this country. Caffey<sup>5</sup> does not mention them. Shanks, Kerley and Twining<sup>20</sup> say that some appendicular concretions contain phosphorus and calcium, and so cast shadows which are apt to be mistaken for ureteric stones, renal stones, gallstones or phleboliths.

A brief survey of the literature reveals that a number of appendiceal concretions have been reported in the past thirty years but seldom has one author published more than one or two such cases, and comparatively few have been found in children.

Weisflog<sup>24</sup> in 1906 reported a case of multiple calcified appendiceal enteroliths correctly diagnosed before operation.

In 1908 Seelig<sup>18</sup> published a case of a thirty-four year old female whose appendix contained a radiopaque "coprolith" adherent to the ureter. Preoperatively this was considered to be an ureteral calculus.

Pfahler and Stamm<sup>16</sup> in 1915 reported a case of a female, aged forty-two, with two radiopaque enteroliths in the appendix.

Douglas and LeWald<sup>8</sup> in 1916 reported 2 cases, aged twenty-one and twenty-three respectively, in which fecal concretions were present in the appendix. One was diagnosed correctly preoperatively. In a footnote they also added the case of a girl of two years in which an appendiceal concretion was visible in a preoperative roentgenogram. They mentioned similar cases observed by Stewart, Case and Eastmond.

Downes<sup>9</sup> in 1917 reported a case of a man, aged twenty-two, with a "fecolith" in the appendix correctly diagnosed.

Packard's<sup>15</sup> appendiceal calculus reported in 1921 was large, measuring 1 by 2 cm. in diameter.

In Mark's<sup>14</sup> case (1924), a man aged forty-four, the appendix was adherent to the posterior peritoneum immediately over the ureter and it contained two concretions in its tip.

Doolittle's<sup>7</sup> stone (1925) resembled a gallstone. Vermooten's<sup>23</sup> stone (1925) was largely calcium phosphate. In the same year, Albert<sup>1</sup> reported a case of a man, aged forty-three, with an appendix containing four calcified fecaliths resembling gallstones.

In 1930 Wells<sup>25</sup> reported a case of an appendiceal abscess from which a hard "concretion" escaped twenty-four hours

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after drainage. The appendix was later found to contain a stone.

In Levi's<sup>13</sup> case, aged nineteen (1934) there was a calcium phosphate stone in a long appendix which was attached to the lower pole of the right kidney.

Shelley<sup>21</sup> (1938) reported a calcified "fecalith" in a ruptured appendix but its presence was not recognized until after operation.

Bunch and Adock<sup>4</sup> in 1939 found a giant



FIG. 1. Case 1. Calcified appendiceal concretion lying in the right side of the pelvis. Subsequent roentgenograms showed that the position changed and no adhesions were present at operation.

"calculus" in the sacculated distal end of an appendix with four smaller calculi near the base. They mentioned no preoperative roentgenograms.

In Shahan's<sup>19</sup> case (1940) twenty-three hard calcified "stones" were found in the appendix of a male, aged thirty-seven. Several were faceted, several octahedral and others rounded or irregular in outline.

Guido<sup>11</sup> in 1941 reported a case of an appendiceal "calculus" in which the preoperative diagnosis was a calculus in the lower third of the right ureter with hydro-nephrosis.

Two cases of appendiceal "fecaliths," one of them calcified associated with suppurative appendicitis, were reported by Jackman<sup>12</sup> in 1942. The calcified one was in a boy of eleven years.

Tripodi and Kruger<sup>22</sup> in 1943 reported a case of appendiceal "lithiasis" in a man thirty-three years of age. They differentiated between ordinary fecaliths which are common and often multiple and appendiceal "calculi" which are rare and usually larger than the lumen of the appendix.

Coleman<sup>6</sup> in 1944 reported a case of a boy eleven years old in which an opaque "calculus" was present in a perforated appendix.

A giant appendiceal "calculus" measuring 2.75 cm. in diameter, in a man aged thirty-four, was reported by Pilcher<sup>17</sup> in 1945.

The purpose of this report is to emphasize the fact that calcified appendicular concretions are not so very uncommon in childhood. The following cases were encountered over a period of eleven years at the Children's Memorial Hospital in Montreal.

#### REPORT OF CASES

CASE 1 (Hosp. No. 7564). L. F., a white female, aged twelve, was admitted to the hospital on February 12, 1934. One month previously she had been brought to the Orthopedic Clinic in the Out-Patient Department, complaining of trouble with her right leg. This was said to have followed an injury which occurred one month before but she could not remember which leg was injured. Movements of the hip and knee were all present but restricted slightly and painful. She saved the right hip, knee and foot when walking. Conservative treatment resulted in no improvement and on February 6, 1934, a roentgenogram of the pelvis and hips was made (Fig. 1). This revealed a dense, laminated oval shadow 1.3 by 0.9 cm. in diameter lying in the pelvis just above the right ischial spine close to the right margin of the sacrum.

On admission to the hospital the abdomen was found to be soft but there was some tenderness in both lower quadrants. A retrograde pyelogram on February 19, 1934, showed the dense shadow to be outside the ureter and also showed that it had moved upward. Re-examination the following day showed that it had moved again. Another examination just before appendectomy on March 2, 1934, showed that it occupied a fourth position.

The appendix was free and easily removed. Roentgenographic examination of the removed specimen confirmed the presence of a laminated concretion in its distal end. A needle pierced this with difficulty. Except for this concretion and the resulting enlargement in this locality the appendix appeared normal.

CASE II (Hosp. No. 5211). P. M., a male Greek, aged eleven years and nine months, was admitted to the hospital on June 8, 1939. The entrance complaints were abdominal pain around the umbilicus and in the right lower

bound down by adhesions. Its mucosa was white and shiny except for several small hemorrhagic areas. The wall was not over 2 mm. in thickness. A concretion was found in the tip and this was also shown in a film of the removed specimen (Fig. 2*B*). It had the same size and shape as the shadow seen in the abdomen before operation and it was described as hard, laminated, brown and spindle shaped. Microscopic examination showed a pin-worm in the lumen of the mid-section of the appendix.

Convalescence was uneventful and the boy was discharged twelve days later.



*A*

*B*

FIG. 2. Case II. *A*, barium enema with calcified concretion near tip of cecum. *B*, roentgenogram of removed appendix containing dense concretion.

quadrant for four weeks and poor appetite for the same length of time. There had been no nausea or vomiting and the pain was not severe. General examination revealed some tenderness and spasm in the right lower quadrant. The Wassermann reaction was negative but the tuberculin test was positive.

Roentgenographic examination of the chest showed a small area of calcium density. An intravenous pyelogram two days after admission revealed no abnormality of the urinary tract but a discrete, clearly outlined, dense shadow 3 by 8 mm. in diameter, was visible just above the inner portion of the right iliac crest, lateral to the ureter. A barium enema on June 12, 1939 failed to fill the appendix but it showed the dense shadow to be just medial to and below the cecal tip (Fig. 2*A*).

Appendectomy was carried out two days later. The appendix was kinked upon itself and

CASE III (Hosp. No. 5092-36). J. T., a male Italian, aged twelve years and nine months, was admitted to the hospital on October 25, 1941. The complaints were epigastric pain and vomiting followed by pain in the right lower quadrant. A markedly tender mass was found in this region. The leukocyte count was 15,000. An appendiceal abscess was diagnosed and conservative treatment was followed for one day. However, the temperature rose to 101.2° F. and the leukocyte count to 22,000 so a stab wound was made over the abscess and a drain inserted. The appendix was not removed at this time. The patient was discharged on November 26, 1941, in good condition.

He was re-admitted on January 23, 1942, with a small discharging sinus in the right lower quadrant. Intravenous pyelography the following day showed no abnormality of the urinary tract. There was a dense laminated shadow

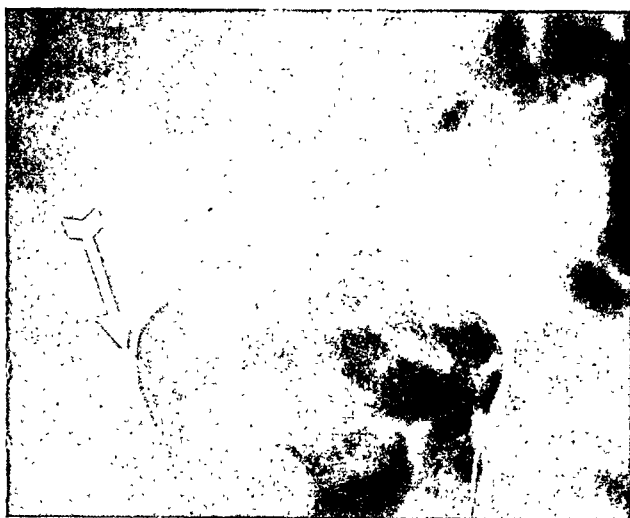


FIG. 3. Case III. The appendiceal concretion overlies the right side of the pelvis and is about 1 cm. lateral to the ureter.

8 mm. in diameter on the right side nearly 1 cm. lateral to the ureter with its upper pole 2.5 cm. below and lateral to the sacroiliac joint (Fig. 3).

Appendectomy was finally carried out on April 17, 1942, when the appendix was found to be free except at its tip where it adhered to the omentum. It was 6.3 cm. long and contained a concretion in its mid-portion as well as several pin-worms. There was considerable fibrosis secondary to acute inflammation in its distal third and a marked constriction was present 1 cm. from the tip.

CASE IV (Hosp. No. 6331). M. S., a female,

aged seven and a half, Hebrew, was brought to the Orthopedic Clinic on June 2, 1942, complaining of pain about the right thigh. Examination showed the hips to be flexed and the lumbosacral curve increased. Roentgenographic examination of the lumbar spine and pelvis on the same day showed no significant bony abnormality. There was a smoothly outlined, dense, oval shadow measuring 1.5 cm. by 0.7 cm. in diameter superimposed on the right iliac bone with its lower pole 2.2 cm. above the hip joint (Fig. 4A). Stereoscopic roentgenograms of this region made three days later showed that this shadow had shifted medially and downward 2 cm. so that its medial margin overlay the brim of the pelvis.

Admission was recommended but she was taken away against advice to enter another hospital when appendectomy was later carried out. I am indebted to Dr. David Berger for a roentgenogram of the removed appendix made on June 22, 1942, which revealed a large calcified concretion identical in shape and size to the shadow seen in the previous roentgenograms of the pelvis (Fig. 4B). The concretion which lay near the tip was continuous with a narrow zone of calcium density extending up the lumen of the appendix almost to its proximal end.

CASE V (Hosp. No. 27952). R. H., a male French Canadian, aged ten years and eight months, was admitted to hospital on January 4, 1944. For the preceding two years there had

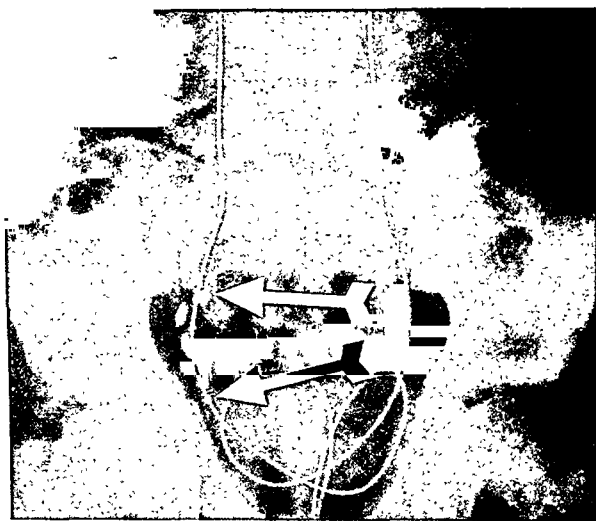


FIG. 4. Case IV: A, in this roentgenogram the appendiceal concretion is superimposed on the right iliac bone but a subsequent examination revealed that it had moved medially to overhang the brim of the pelvis. B, removed appendix with large concretion and narrow calcified zone of calcium density extending up the lumen almost to the proximal end.

been suprapubic pain on urination and he was forced to assume a peculiar position to carry out this act. Chronic constipation had been present since early childhood. The general examination was essentially negative except for a positive tuberculin test. The Wassermann reaction was negative. Cystoscopic examination revealed nothing abnormal, and a catheterized specimen of urine contained an occasional white blood cell but was sterile on culture.

An intravenous pyelogram on January 8, 1944, showed no abnormality of the urinary tract. There were several areas of calcium density to the left of the fourth lumbar vertebra

tip, smaller in size (Fig. 5*B*). The most proximal concretion contained a minute metallic object about 0.5 mm. in diameter. Analysis of the concretion at the Montreal General Hospital by Dr. I. M. Rabinovitch showed it to contain calcium phosphate with a small amount of fat. The metallic fragment was identified as lead contaminated with traces of iron. Pathological examination showed the proximal and distal concretions to be firmly attached to the mucosa. They were all hard laminated objects which completely filled the lumen of the appendix. There was no evidence of any inflammatory reaction, but the mucosa and submucosa were thinned. He was discharged seven



A



B

FIG. 5. Case v. *A*, five dense shadows are present in the right side of the pelvis. These were shown to be outside the ureter when it was distended with diodrast. Calcified lymph nodes can be seen to the left of the fourth lumbar vertebra. *B*, roentgenogram of removed appendix containing six dense concretions. The most proximal one contains a minute metallic fragment. The smaller concretion near the tip was not diagnosed before operation.

apparently in the mesenteric nodes. Five smoothly outlined dense oval areas were seen in the pelvis below the right sacroiliac joint. The largest of these was 1.3 cm. in length and the smallest 0.5 cm. The spaces between them varied from 2 mm. to 5 mm. Retrograde pyelography two days later showed them to lie close to the plane of the ureter but not in it (Fig. 5*A*).

Appendectomy was performed six days later. The appendix was found in the pelvis and palpation revealed the presence of multiple hard concretions. Roentgenographic examination of the removed specimen confirmed the presence of the five previously diagnosed concretions and also showed an additional one close to the

days later and there were no further complaints.

CASE VI (Hosp. No. 30904). B. P., a male Hebrew, aged six years and eight months, was admitted to the hospital on August 10, 1944. The entrance complaints were pain in the right thigh and inability to bear weight on the right leg. He had fallen the previous day, but had felt well until the morning of admission. Examination showed the right leg to be slightly flexed and externally rotated. Moderate pain was produced by all motions of the hip. The abdomen was soft but there was a sense of resistance to deep palpation in the right lower quadrant, and there was mild tenderness on

the right side on rectal examination. The temperature and pulse were normal, leukocyte count 7,800, and the Wassermann and tuberculin tests negative.

Stereoscopic roentgenograms revealed some tipping of the pelvis, with the right iliac crest somewhat lower than the left and slight abduction of the right femur. An oval dense shadow 1.4 cm. by 0.5 cm. in diameter was present anterior to the right iliac bone, about 1 cm. lateral to the central portion of the sacroiliac

was admitted to hospital on March 23, 1945. There had been vomiting, abdominal pain, constipation and anorexia for five days. Measles was the only previous illness. Palpation revealed tenderness and splinting of the right side of abdomen and in the right flank, where there was a poorly defined mass. Rectal examination elicited tenderness especially on the right side. The temperature was 101.2° F. and the pulse 125. The Wassermann and Mantoux tests were negative.



FIG. 6. Case VI. *A*, roentgenogram of pelvis with calcified concretion superimposed on right iliac bone. There is some tipping of the pelvis and slight abduction of the right femur. *B*, roentgenogram of removed appendix with concretion. Note the denser area in the concretion.

joint (Fig. 6*A*). In the upper portion of this shadow there was a smoothly outlined denser area measuring 5 or 6 mm. in diameter. The same roentgenographic findings were noted the following day and a lateral view proved the dense shadow to be situated anteriorly.

Appendectomy was performed and the appendix was found to contain a large concretion. Roentgenographic examination of the specimen showed the concretion to be radiopaque and to have the same shape, size and configuration as the shadow seen in the previous films (Fig. 6*B*).

The pathological report was appendix containing a hard concretion with no microscopic evidence of inflammatory reaction. It lay in the proximal 3.5 cm. and this portion was consequently distended.

An intravenous pyelogram the following day showed no abnormality of the urinary tract. A rounded, slightly laminated shadow was present just above the right iliac crest, 4 cm. lateral to the right ureter (Fig. 7*A*).

Conservative therapy (Ochsner-Sherren) was adopted for three weeks. On April 8, 1945, plain roentgenograms showed that the dense shadow was still present above the iliac crest. Operation was carried out on April 14, 1945. The appendix and an appendiceal abscess were found to lie in the retrocecal space. The abscess walls and the appendix were removed without rupturing and the wound was closed without drainage. There was a concretion in the appendix and roentgenograms of this showed it to correspond to the shadow seen in the previous examinations (Fig. 7*B*). The pathological report was acute obstructive appendicitis with perforation and fecal concretion. This was situated at the tip and the perforation had oc-

CASE VII (Hosp. No. 33873). W. E., a white female, born in Montreal, aged five and a half,

curred just proximal to the tip. The patient was discharged eleven days later.

CASE VIII (Hosp. No. 1990). L. G., a male French Canadian, aged twelve years seven months, was admitted on June 16, 1937. The entrance complaints were pain in the abdomen for forty-eight hours and nausea but no vomit-

toneum. It had perforated and there was a small quantity of pus in the peritoneum.

Examination of the removed specimen showed the serosa to be reddened and rough. The perforation was 0.5 cm. from the distal end and a concretion was present in this region. This was hard and measured 0.7 by 0.5 cm. in diameter. Roentgenographic examination show-



*A*

*B*

FIG. 7. Case VII. *A*, intravenous pyelogram showing the appendiceal concretion lying just above the right iliac crest. The appendix was later shown to be retrocecal. *B*, roentgenogram of removed appendiceal concretion.

ing. There had been a similar attack five months previously. Initially the pain had been around the umbilicus but it soon radiated to the right lower quadrant. Examination showed splinting of the right side of the abdomen with definite tenderness in the right lower quadrant. Rectal examination suggested fullness on the right. The tuberculin and Wassermann tests were negative. The leukocyte count was 24,600. Urinalysis was negative. The temperature was 99.2° F. and the pulse 90.

Appendectomy was performed the same day. A mass consisting of the cecum and the great omentum which was wrapped around the appendix was present low in the right iliac fossa. The appendix was retrocecal and buried in the posterior surface of the cecum under the peri-

ed it to be dense with a discrete slightly irregular outline.

#### DISCUSSION

Correct preoperative diagnoses of calcified appendiceal concretions were made in 7 of these cases. In the eighth case no roentgen examination was carried out before operation. In 1 case the appendix contained six concretions, five of which were diagnosed. It is interesting to note that, in this appendix, the most proximal concretion contained a minute metallic foreign body which may have represented the nidus for its formation. Possibly the more distal

ones formed secondarily due to partial obstruction of the lumen of the appendix.

In 3 cases the complaints were referred to the right hip and thigh and the calcified concretions were first seen in films of the pelvis. In 2 of these children the appendices on pathological examination showed no inflammatory reaction. Unfortunately no pathologic report on the third case is available. In 3 other cases the appendices had perforated presumably before admission to hospital. Pin-worms were found in 2 cases.

The most common location for a concretion in this series was near the tip—5 cases. One was situated in the middle third, one was in the proximal portion, and in the other case there were 6 concretions fairly evenly distributed from the base to the tip. One concretion contained a much denser area in its proximal portion suggesting that this had formed first and the remainder at a later period.

There were 5 males and 3 females. The youngest patient was five and a half years old and the oldest twelve years. Two were French Canadians, 2 were Hebrews, 1 was of Italian parentage, 1 of Greek parentage and 2 were of Anglo-Saxon descent.

In 2 instances the calcified shadows were shown to be movable, one having been seen in four different positions. In no case was there any history of the previous administration of barium which might account for the increased density. Chemical analysis of one concretion revealed calcium phosphate plus a small amount of fat.

Differential diagnosis was not difficult. Ureteral calculi are rare in children, at least in Montreal, and only one was seen at the Children's Memorial Hospital during the period in which these 8 calcified appendiceal concretions were encountered. Nevertheless, in at least half the cases the position of the shadows was such that a ureteral calculus had to be excluded. This was readily accomplished by pyelography. A foreign body in the small or large intestine was a possibility in at least 1 case but

the failure to move with intestinal contents seemed to exclude this.

Calcified lymph nodes are relatively common but they do not tend to be laminated and they usually have a mulberry appearance with an irregular outline. Phleboliths and radiopaque gallstones are rare in childhood and should not cause any confusion.

#### SUMMARY

Eight verified examples of calcified appendiceal concretions in children between the ages of five and a half and twelve years are reported, seven diagnosed before operation.

In seven cases these were single but in one case there were six in the appendix, the most proximal one containing a minute metallic center.

When a calcified appendiceal concretion is diagnosed the appendix should be removed as the incidence of perforation is high—37.5 per cent in this series.

I am indebted to Dr. Ross Golden, Director of the Department of Radiology, Presbyterian Hospital, New York, for his interest and advice in the preparation of this paper. I also wish to thank Dr. David Berger of Montreal, Que., for his kindness in providing me with the roentgenogram of the removed appendix of Case IV.

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## STUDIES ON BONE MARROW IN VITRO

IV. THE EFFECT OF ROENTGEN RAYS ON  
EXPLANTED BONE MARROW\*

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THE literature relating to the effect of roentgen rays on the blood-forming organs is vast and contradictory. The lack of unanimity among the various reports may be attributed in part to differences in the experimental conditions which vary in regard to irradiation technique, the choice of the animal and of the region irradiated, and in regard to the time interval between irradiation and examination. However, the difficulties in obtaining reliable evidence essential for the understanding of the response of the bone marrow to irradiation are certainly not of a purely technical nature. These difficulties lie to a great extent also in the complexity of factors which govern the function of the bone marrow *in vivo*, and which may determine its response to irradiation. It seemed to us, therefore, of advantage to study the direct effect of roentgen rays on bone marrow under conditions uncomplicated by somatic factors. The bone marrow explanted *in vitro* represents a completely autonomic entity with a given cell population, which can be exposed to a direct and uniform action of roentgen rays. The analysis of the response to irradiation of the bone marrow functioning in a simple and easily controllable environment is thus obviously facilitated.

The effect of roentgen rays on bone marrow surviving *in vitro* was studied by Osgood and by Gregori. Osgood<sup>39</sup> irradiated with doses of from 50 to 2,000 r suspensions of human marrow cells maintained in a medium consisting of citrated plasma and balanced salt solution or serum, and examined the cellular composition of the suspensions after one to seven days. He stated that the number of lymphocytes, progranulocytes and granulocytes in the bone marrow irradiated

*in vitro* begins to decrease during the first twenty-four hours of incubation and reaches very low levels after seven days. Increase in the roentgen-ray dose enhances this effect, but not in direct proportion to the dose applied. Disintegration of hemic cells as a result of roentgen-ray application could not be observed by this author. The majority of the cells in the irradiated cultures were similar in morphology, motility and phagocytic ability to the corresponding cells in the control non-irradiated cultures. Gregori<sup>17</sup> estimated the surface of outgrowth areas in cultures of bone marrow irradiated with high roentgen-ray doses. According to this author doses up to 10,000 r have no effect on the extent of cell migration from the irradiated bone marrow fragments. The migrated cells, however, were frequently damaged. This author worked with living non-stained cultures and did not indicate the type of cells affected.

## MATERIAL AND TECHNIQUE

A. *Material and Culture Technique.* The bone marrow from the tibia of rabbits six to eight weeks of age was used. The culture technique employed has been as described in the first paper of this series.<sup>41</sup>

B. *Technique of Irradiation.* Irradiations were carried out with a demountable roentgen tube at 35 kv., and 2 ma. The tube had a copper anticathode, and a window of aluminium foil 30  $\mu$  in thickness. Absorption analysis showed that the rays penetrating through the window foil were mainly the characteristic CuK-rays. Radiation was administered at a target-object distance of 3.7 cm. The roentgen-ray intensity at the distance of the irradiated object was about 10,000 r per minute for a tube current of 2 ma.

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*C. Experimental Procedure.* The fragments of bone marrow, about 1 to 2 mm. in diameter, were placed in a hollow slide, moistened with a drop of Tyrode's solution and covered with a mica cover glass  $30\mu$  in thickness. The fragments thus mounted were irradiated and planted immediately after irradiation in the culture medium. The tubes containing the cultures were incubated for two, four, eight and twenty-four hours at  $37^{\circ}\text{C}$ . The non-irradiated controls were treated in exactly the same way. After incubation the bone marrow explants were fixed together with the plasma clot in Zenker's fluid. Serial sections,  $4\mu$  in thickness, were cut from the material embedded in celloidin-paraffin; they were stained with hematoxylin-eosin and with Giemsa's stain.

#### OBSERVATIONS

##### *A. Mitoses in the Irradiated Bone Marrow Cultures.\**

1. Mitotic frequency. The mitotic activity of the bone marrow cultures was estimated by counting the number of mitoses in irradiated and control cultures respectively. The number of mitoses present in twenty microscopic fields of 0.4 mm. diameter was determined in each culture. Although the total number of mitoses counted was small, these counts clearly indicate the general trend of changes in mitotic activity occurring in the irradiated cultures.

The mitotic counts in irradiated and non-irradiated bone marrow cultures are given in Table 1.

Bone marrow cultures irradiated with 250 r show two hours after irradiation a drop in the number of mitoses to approximately 15 per cent of that in the non-irradiated controls. Four hours after irradiation with the same dose the number of mitoses rises appreciably and reaches after eight hours values almost equal to those of the controls. The number of mitoses twenty-four hours after irradiation was practically the same as in the non-irradiated fragments.

\* A preliminary report on the mitoses in the irradiated bone marrow cultures has been published.<sup>42</sup>

The mitotic behavior of the bone marrow cultures irradiated with 500 r was similar to that of the cultures irradiated with 250 r. There is a drop in the number of mitoses two hours after irradiation, followed after four hours by a rise; normal values were reached after eight hours.

After irradiation with 1,000 r there is no appreciable increase of mitoses four hours after irradiation; but after eight hours the number of mitoses reaches normal values as in the case of irradiation with smaller doses.

In cultures irradiated with 2,500 r the number of mitoses two and four hours after irradiation remains at a very low level. The increase in mitoses can be observed only eight hours after irradiation; this increase is slight and amounts to approximately 35 per cent of the values in controls. No further increase in mitoses takes place twenty-four hours after irradiation with this dose.

There is almost complete disappearance of mitoses two and four hours after irradiation with 5,000 r. After eight hours the number of mitoses increases somewhat and remains low after twenty-four hours.

The mitotic behavior of the irradiated bone marrow cultures in relation to the non-irradiated control cultures is represented graphically in Figure 1.

2. Abnormal mitoses. The treatment with roentgen rays affects not only the mitotic frequency of the irradiated culture, but also leads to the appearance of abnormal mitotic figures (Fig. 2). The following abnormalities were observed:

- (1) Stickiness of chromosomes
- (2) Displacement of chromosomes
- (3) Non-disjunction of chromosomes
- (4) Clumping and pyknosis of chromosomes
- (5) Breaking of chromosomes with scattering of chromosomal particles all over the cell body.

In addition to these changes multipolar mitoses were seen frequently in the irradiated bone marrow cultures. The patho-

logical mitoses were present in myeloid and erythroid cells, as well as in stroma cells. Dividing cells which show many abnormalities can already be found after irradiation with 250 r, the number of abnormal mitoses increasing with the dose applied. But even

### B. Regressive Cell Changes in Irradiated Bone Marrow Cultures.

In the following the description of the regressive changes produced by roentgen rays in the various cell elements of the bone marrow will be given.

TABLE I

## MITOSES IN THE IRRADIATED BONE MARROW CULTURES

(The number of mitoses present in 20 microscopic fields of 0.4 mm. diameter was determined for each culture)

A. Number of mitoses in irradiated bone marrow cultures.

B. Number of mitoses in non-irradiated control cultures.

C. = A expressed as a percentage of B.

Exper. No.	2 hours after irradiation			4 hours after irradiation			8 hours after irradiation			24 hours after irradiation		
	A	B	C	A	B	C	A	B	C	A	B	C
<i>Irradiation with 250 r</i>												
71	3	13	23	14	16	87	30	28	107	10	12	83
74	2	24	9	8	22	37	20	28	71	12	12	100
	mean		16%	mean		62%	mean		89%	mean		92%
<i>Irradiation with 500 r</i>												
70	4	34	12	14	32	44	21	31	68	20	20	100
77	6	20	30	13	26	50	25	20	125	9	12	75
	mean		21%	mean		47%	mean		97%	mean		88%
<i>Irradiation with 1,000 r</i>												
76	8	22	37	8	34	23	20	18	111	14	14	100
69	0	14	0	8	32	25	24	26	92	15	22	68
	mean		18%	mean		24%	mean		102%	mean		84%
<i>Irradiation with 2,500 r</i>												
68	0	24	0	4	26	15	9	40	23	6	14	43
67	2	26	8	4	16	25	6	22	27	6	18	33
	mean		4%	mean		20%	mean		25%	mean		38%
<i>Irradiation with 5,000 r</i>												
66	0	38	0	0	32	0	5	32	15	8	32	25
63	1	38	3	3	20	15	7	20	35	4	12	33
	mean		1%	mean		8%	mean		25%	mean		29%

in cultures irradiated with 5,000 r, side by side with severely altered mitoses, single cells can be found which undergo the process of mitosis normally.

*Hemocytoblasts:* No retrograde changes could be observed in hemocytoblasts with any of the doses applied.

*Basophile and polychromatophile erythro-*

*blasts and normoblasts:* In the precursors of the red cells the nucleus is the main site of alteration. The intensity of nuclear disintegration increases with the state of maturation of the nucleus. The radiosensitivity of the basophile erythroblasts is not much greater than that of the stem cells; on the other hand, the hemoglobin containing erythroblasts with denser nuclei and still more the normoblasts display the most

or in the form of irregular clumps which coalesce to rosette-like figures. The nuclei thus altered are progressively transformed into large, almost colorless, sharply outlined vesicles in which in addition to one or more chromatin clumps foamy nucleoplasm may be seen. In later stages the nuclear vesicles disappear, the chromatin becomes scattered throughout the cytoplasm and finally dissolves completely.

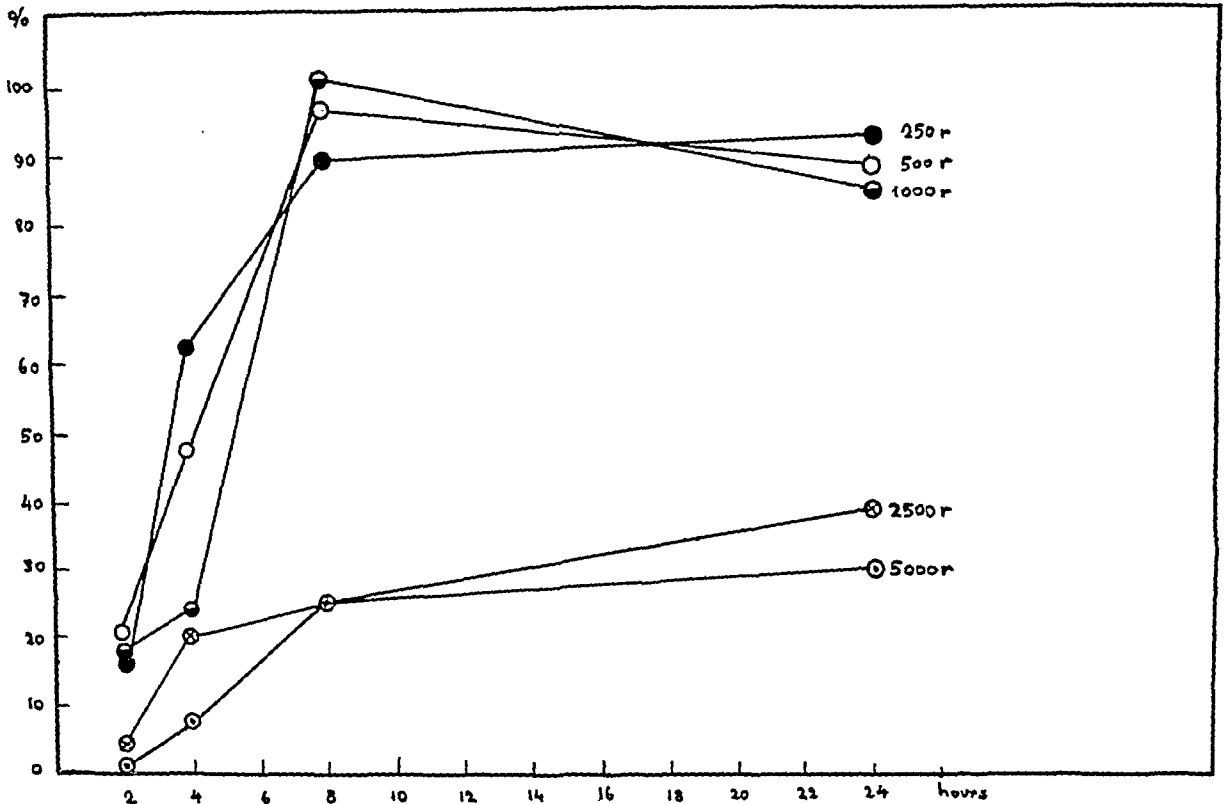


FIG. 1. Effect of roentgen rays on mitoses in bone marrow cultures. Abscissae: time after irradiation in hours. Ordinate: number of mitoses in irradiated cultures in percentages of number of mitoses in non-irradiated cultures.

pronounced alterations. The first sign of nuclear damage in erythroblasts and normoblasts is the uneven distribution of basophile chromatin, which accumulates on the periphery of the nucleus, leaving the central zone partly or completely free of chromatin. The nucleus thus acquires the appearance of a basophilic ring. The central chromatin-free area is sometimes empty, sometimes it contains eosinophilic material. As the changes progress the basophilic ring breaks down, and the remnants of chromatin collect in small deeply staining drops

*Erythrocytes:* After irradiation with doses up to 5,000 r the mature red cells are well preserved during the entire period of observation.

*Promyelocytes and myelocytes:* The regressive changes in the promyelocytes and myelocytes involve the nucleus as well as the cytoplasm. The outline of the damaged cells becomes irregular and the cytoplasm appears muddy and slightly brownish in color in the hematoxylin-eosin preparations. The nuclei either undergo karyolysis or become pyknotic.

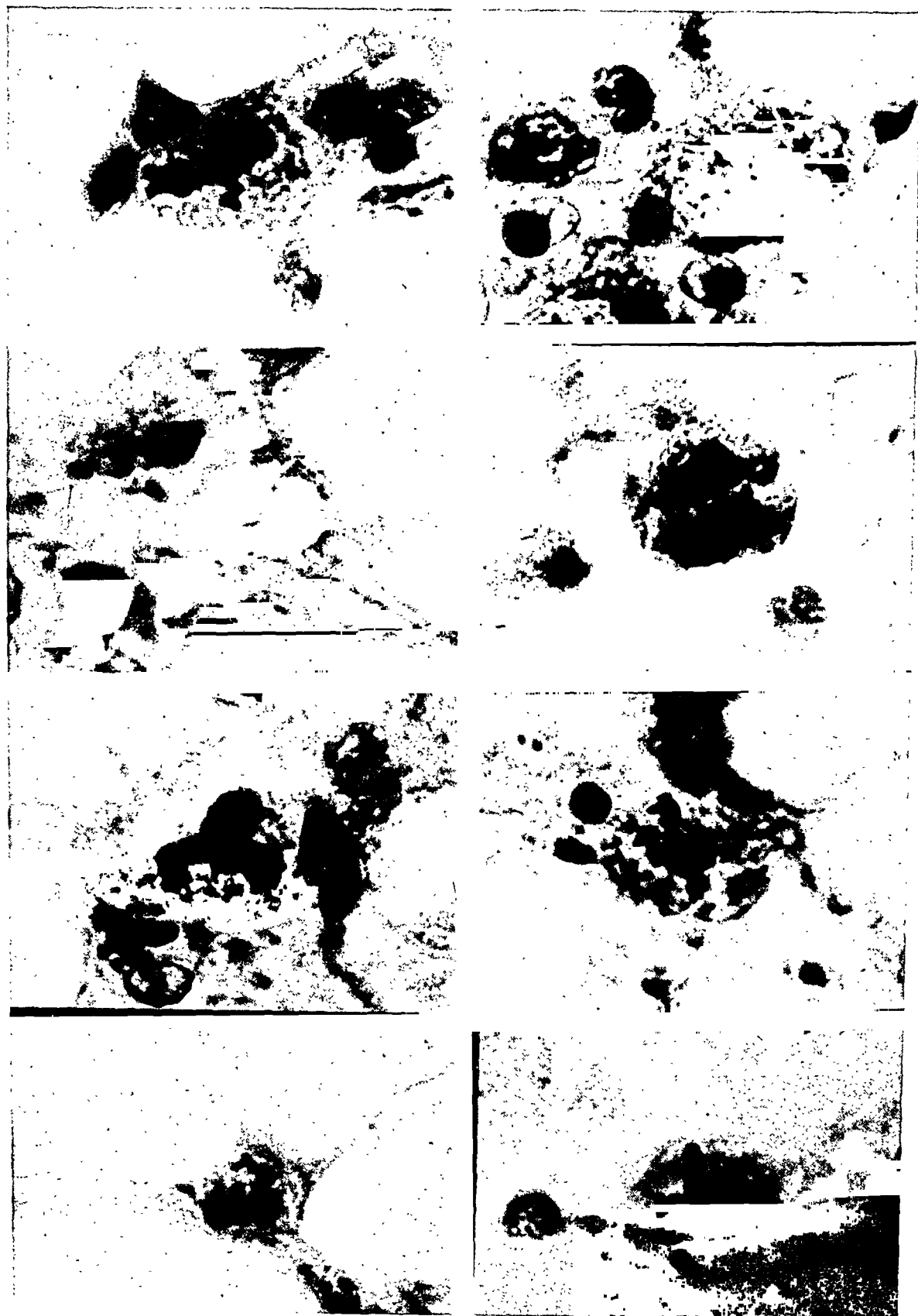


FIG. 2. Pathological mitoses in irradiated bone marrow cultures. Experiment No. 75. Irradiated with 2,500 r. Fixed after twenty-four hours of incubation. Hematoxylin-eosin stain.  $\times 1700$ .

*Polymorphonuclear leukocytes:* With all doses applied no changes were observed in the mature leukocytes during the entire period of observation.

*Megakaryocytes and stroma cells* did not display definite changes following irradiation.

The retrograde changes in cells of the erythroid and myeloid series could be observed after treatment with all doses beginning with 500 r. The alterations became more frequent and more pronounced with increase of the dose (Fig. 3).

#### C. *The Cellular Pattern of the Irradiated Bone Marrow.*

The cellular pattern of the irradiated bone marrow varies considerably with the dose applied.

The cellular content of the irradiated bone marrow is not affected by irradiation with 250 r. The cellularity of cultures irradiated with 500 and 1,000 r also remains unchanged or is only slightly reduced two, four and eight hours after irradiation. However, twenty-four hours after irradiation, all cultures irradiated with the latter doses show a distinct decrease in hemic cells, chiefly in erythroblasts and myelocytes.

The effect of 2,500 and 5,000 r on the cellular pattern of the irradiated bone marrow is much more accentuated. The cultures irradiated with these doses show a moderate reduction of both erythroid and myeloid cells two, four and eight hours after irradiation. Twenty-four hours after roentgen-ray application the number of hemic cells is considerably reduced in cultures irradiated with 2,500 r. The remaining hemic cells are chiefly hemocytoblasts and promyelocytes as well as hypersegmented granulocytes. Cultures irradiated with 5,000 r show after twenty-four hours of incubation a complete or almost complete aplasia; the irradiated fragments consist then of proliferating stroma cells which form a meshwork without any or with only single hemic cells and a few megakaryocytes (Fig. 4 and 5).

#### D. *Abnormal Cells in Irradiated Bone Marrow Cultures.*

The effect of irradiation on the bone marrow is also manifested by the appearance of abnormal hemic cells, chiefly hemocytoblasts and promyelocytes. The nuclei of these cells in the irradiated cultures show a definite tendency towards segmentation. They may be indented, deeply constricted or divided into several segments. The process of nuclear segmentation in the precursors is not followed by cytoplasmic changes, the cytoplasm remaining deeply basophilic without any or with only a few immature granules. The segmentation of the nuclei is often associated with conspicuous hypertrophy of the cell body.

In addition to these abnormal cells, another type of cell could often be seen in the irradiated culture which was characterized by its large size, by multiple nuclei arranged in the form of a closed ring around the central area and by eosinophilic granulation of the cytoplasm. These cells bear a close resemblance to megakaryocytes and differ from the latter chiefly by the presence of granules.

In cultures irradiated with 2,500 r and 5,000 r polygonal and spindle-shaped cells may also be found, the cytoplasm of which contains numerous eosinophilic granules. It is difficult to decide whether these cells are abnormal myelocytes or whether they are stroma cells which have phagocytized the granules of disintegrated myeloid cells.

#### RESULTS AND COMMENT

The experiments reported above show that the effect of roentgen rays on the explanted bone marrow is manifested by:

- (A) Depression of the mitotic activity and appearance of pathological mitoses.
- (B) Retrograde changes in hemic cells.
- (C) Decrease in cellularity.
- (D) Appearance of abnormal hemic cells.

(ad A) The irradiation of the bone marrow is followed by a marked reduction in the number of mitoses in hemic cells. The decrease in mitoses is at its lowest two

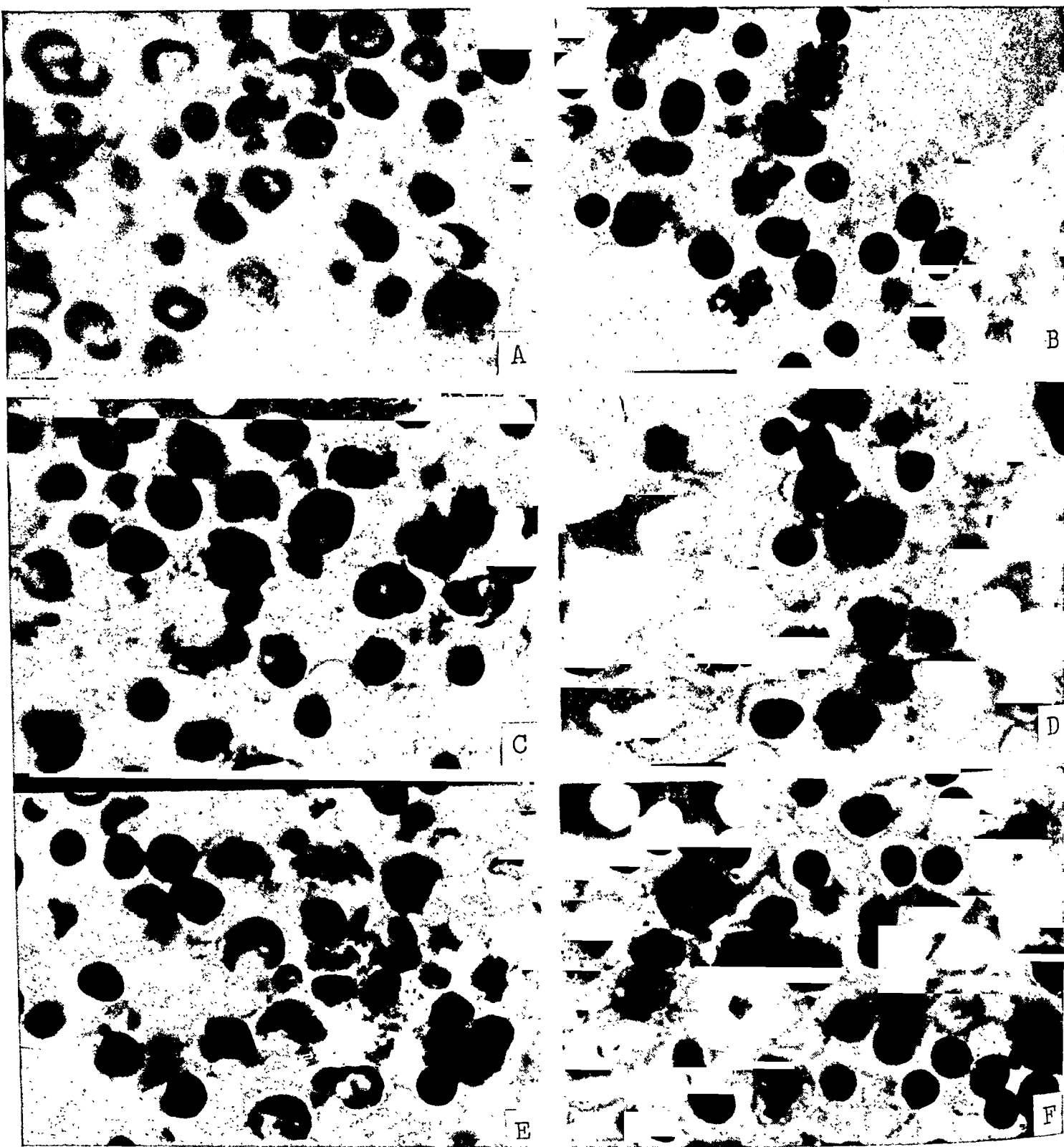


FIG. 3. Degeneration of the irradiated bone marrow cells.

Experiment No. 79/14. *A*, irradiated with 5,000 r. *B*, non-irradiated control. Fixed after four hours of incubation. Experiment No. 66/4. *C*, irradiated with 5,000 r. *D*, non-irradiated control. Fixed after three hours of incubation. Experiment No. 66/4. *E*, irradiated with 5,000 r. *F*, non-irradiated control. Fixed after three hours of incubation. Hematoxylin-eosin stain.  $\times 1650$ .

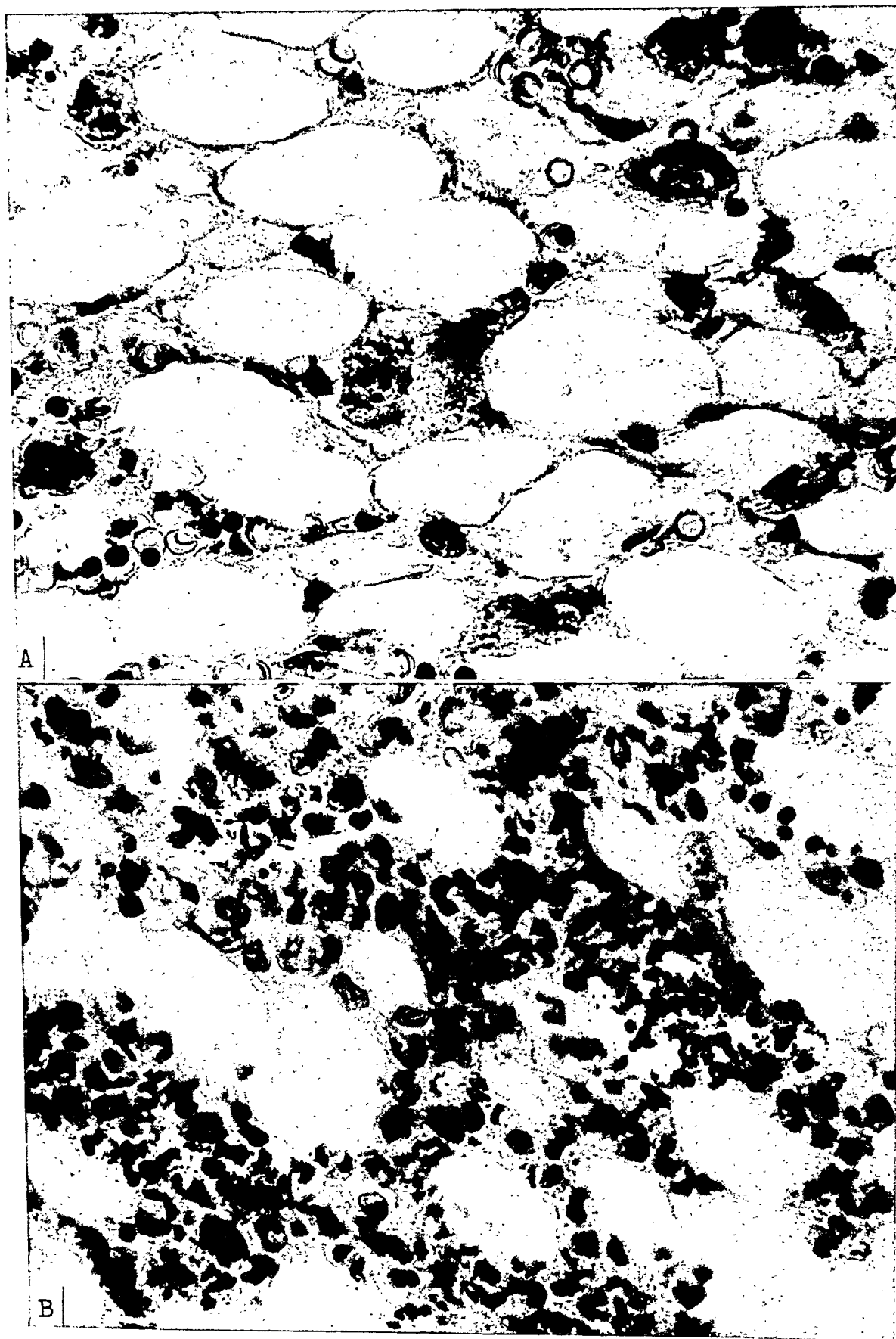


FIG. 4. Aplasia in irradiated bone marrow cultures. Experiment No. 79/18. *A*, irradiated with 5,000 r. *B*, non-irradiated control. Fixed after twenty-four hours of incubation. Hematoxylin-eosin stain.  $\times 820$ .



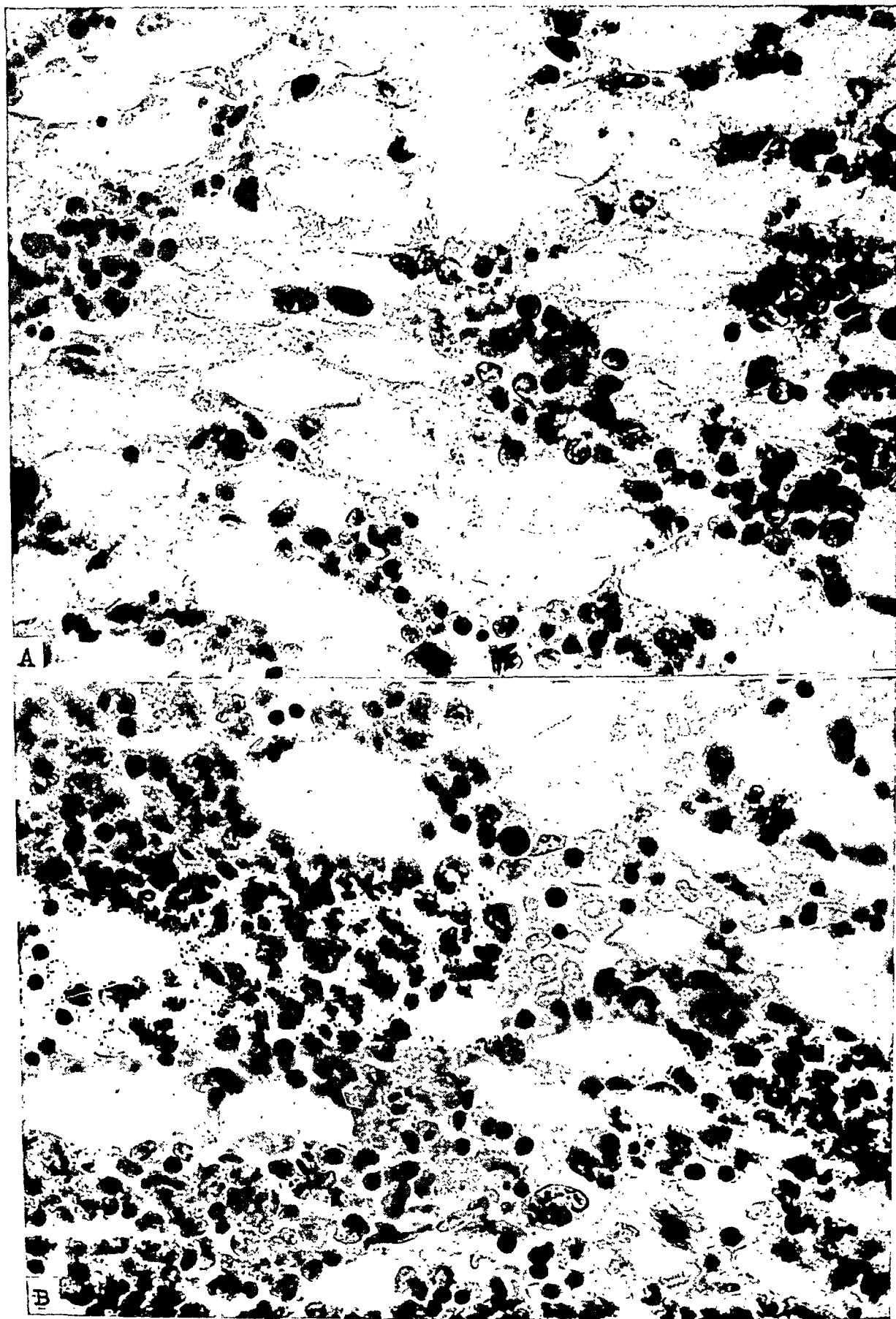


FIG. 5. Aplasia in irradiated bone marrow cultures. Experiment No. 66/17. *A*, irradiated with 5,000 r. *B*, non-irradiated control. Fixed after twenty-four hours of incubation. Hematoxylin-eosin stain.  $\times 750$ .

hours after irradiation with all doses applied. Following the application of 250 r and 500 r an appreciable recovery of the mitotic activity is observed four hours after irradiation. A complete recovery is attained after eight hours. Cultures irradiated with 1,000 r show no significant recovery after four hours, but only after eight hours; also in this case the recovery is complete at this time. Twenty-four hours after irradiation the cultures irradiated with 1,000 r and less show an abundance of mitoses and normal cellularity. A distinctly different behavior was observed in cultures irradiated with 2,500 and 5,000 r. In cultures treated with these doses recovery of the mitotic activity taking place eight hours after irradiation is poor, and the mitotic count remains at very low levels during the entire period of observation.

The irradiation with all doses applied leads, in addition to changes in the mitotic counts, to the appearance of abnormal mitotic figures.

Decrease of the mitotic activity in bone marrow irradiated *in vivo* was noted by Mottram,<sup>37</sup> Fieschi<sup>15</sup> and Hsü and Ma.<sup>24</sup> Data on the relation between the doses applied and their effect on mitotic activity were given only by the last author who states that after irradiation with doses of 2,500 and 5,000 r mitoses are rare or entirely absent, but they are present in bone marrow treated with 1,000 r. These findings are parallel to the results obtained in the present investigation on the bone marrow *in vitro*.

Osgood,<sup>39</sup> in his experiments on human bone marrow *in vitro*, found a decrease of mitotic activity in the irradiated hemic cells. Because of the scarcity of cell divisions in the material studied no figures are given to substantiate this observation. Pathological mitoses in bone marrow irradiated *in vivo* were described by Jolly<sup>25</sup> and by Langendorff and Papperitz.<sup>30</sup>

In this connection it seems worth while to compare the roentgen-ray effect on mitosis in bone marrow cultures with that in cultures of common mesenchyme cells. The data available in the literature make this comparison possible.

Strangeways and Oakley<sup>49</sup> and Strangeways and Hopwood<sup>48</sup> were the first to show

that irradiation with roentgen rays (doses from 1 to 160 e measured with Friedrich's iontoquantimeter) provoke in fibroblast cultures a fall in mitoses which takes place very soon after exposure. Canti and Donaldson,<sup>6</sup> Canti and Spear,<sup>7,8</sup> and Spear<sup>46</sup> have demonstrated that mitoses in cultures of fibroblasts irradiated with radium (2.5 to 100 mg. radium element filtered with 0.5 mm. platinum at a distance of 0.5 cm. from the culture) gradually decrease to a minimum, which is reached eighty minutes after exposure. On further incubation recovery takes place and the mitotic count is normal after two hours and fifty minutes. The initial fall of mitoses is considerable, even when small roentgen-ray doses are applied. According to Lasnitzki<sup>31</sup> the dose of 96.7 r already causes a temporary inhibition of mitotic division, the total mitotic count decreasing to 23 per cent of normal. Juul and Kemp<sup>26</sup> subjected fibroblast cultures to roentgen rays (300–2,000 r) and radium and found maximal decrease in mitoses one hour after irradiation. The inhibition of mitoses by smaller doses was followed by a rapid recovery.

It follows from the above that a fibroblast colony proliferating *in vitro* responds to irradiation with roentgen rays or radium by rapid decrease in the mitotic count. The marked fall in mitoses occurs soon after irradiation and can be observed within a wide range of dosages. The initial inhibition of mitoses is followed by recovery of cell division a few hours after irradiation. It is thus evident that the immediate roentgen-ray effect on mitoses in fibroblast cultures and in the cultures of bone marrow is essentially the same.

(*ad B*) Retrograde changes in hemic cells are another feature of the irradiated bone marrow. They were found in erythroid as well as in myeloid cells, especially in erythroblasts and normoblasts, as well as in promyelocytes and myelocytes. The stem cells and mature white and red cells display no evident damage. Megakaryocytes and stroma cells are also not visibly affected. The alterations involve the nuclei of

erythroid and myeloid cells and also the cytoplasm of the latter. The cell damage appears after irradiation with doses of 500 r and becomes more accentuated with increasing doses.

Most authors who have studied the reaction of the bone marrow *in vitro* to irradiation noted regressive cell changes as the result of roentgen treatment.<sup>1,4,5,12,18,19,20,22,25,27,29,30,33,36,40,43,45,47,50,52</sup> Other investigators failed to observe this effect. Lingley, Gall and Hilcken,<sup>34</sup> using doses up to 3,000 r, state that no evidence of intrinsic cellular degeneration could be found in the irradiated bone marrow. Casati<sup>9</sup> explains the nuclear alterations observed by him after roentgen treatment as technical artefacts. Osgood<sup>39</sup> also denies the presence of degenerative changes in human marrow cells, which were exposed to irradiation *in vitro*.

It is well known that roentgen rays produce degenerative changes also in cultures of common mesenchymal cells irradiated *in vitro*. These changes are: fragmentation of nuclei, disorganization of cytoplasm and disruption of the cells. As in the case of irradiated bone marrow retrograde cell changes in fibroblasts can be seen soon after irradiation. In both instances the damaged cells disappear several hours after exposure to roentgen rays.

Cox,<sup>11</sup> and later Lasnitzki,<sup>32</sup> claims that when doses up to 2,500 r are applied the cell damaging effect due to irradiation is intimately correlated with mitotic cell division. The cells which are no longer capable of going through the process of division, fail to complete the mitosis and perish; other injured cells divide abnormally and degenerate later. In the light of this conception it is not difficult to explain why erythroblasts as well as myelocytes are the most damaged elements in the irradiated bone marrow, since these cells represent mitotically the most active component of the marrow parenchyme. The striking resistance of hemocytoblasts to roentgen rays is worth mentioning in this connection. The complete integrity of these cells after irradiation with all doses applied conforms

with the view that in the bone marrow cell formation takes place primarily not at the expense of the stem cells but of the more mature elements. (Maximow.)

(*ad C*) The damage produced by roentgen rays on hemic cells and the inhibitory effect of irradiation on cell multiplication lead to transitory or permanent decrease in cellularity of the irradiated bone marrow. The irradiation with doses below 2,500 r causes a moderate and temporary reduction in hemic cells. On the other hand, explants irradiated with 2,500 and 5,000 r become almost completely depleted of specific cell elements twenty-four hours after irradiation. The decrease of hemic cells following irradiation with all doses applied occurs mainly at the expense of myelocytes and erythroblasts, i.e. those cells which constitute the majority of the mitotically active elements of the bone marrow. No evidence could be found indicating a difference in the radiosensitivity of the erythroid and the myeloid series; the state of maturation of a given cell seems to be the only decisive factor. The few hemic cells remaining in fragments irradiated with 2,500 and 5,000 r are stem cells, erythrocytes and rare mature granulocytes.

There is no evidence of stimulation of bone marrow activity following irradiation with all doses applied.

There is general agreement that the response of bone marrow *in vivo* to roentgen rays results in a decrease in the number of specific cell elements.<sup>2-5,10,12,16,18,19,21-24,27-30,33,34,35,38,43,44,46,47,51,53</sup>

With smaller doses the hemic cells regenerate after a certain period and the cellular content of the bone marrow returns to normal or even exceeds the normal level. Application of high doses is followed by complete aplasia of the bone marrow. Most authors claim that the reduction in hemic cells in bone marrow irradiated *in vivo* occurs to a great extent at the expense of white cells, in the first place at that of the immature granulocytes. The measure of participation of erythroid cells in the process of depletion is not definitely established. Besides the authors who stress their relative low radiosensi-

tivity,<sup>2,9,19,24,27,36,38,45</sup> there are others, who consider them as particularly radiosensitive.<sup>12,13,16,25,34,47</sup>

(*ad D*) In addition to the above described effects the appearance of pathological forms of hemic cells, as the result of irradiation of the bone marrow *in vitro*, was noted. The outstanding abnormal feature consists of hypertrophy of the cell body and excessive segmentation of the nuclei in early precursors suggesting a discrepancy in the rate of maturation of the cytoplasm and the nucleus.

Considering the results obtained in irradiation experiments on bone marrow *in vitro* in the light of our knowledge on the roentgen-ray effects on bone marrow *in vivo* the following *conclusions* can be made.

The response of the bone marrow to irradiation *in vitro* is essentially the same as *in vivo*. In both cases the roentgen rays inhibiting the mitotic power of the cells and producing regressive cell changes cause depletion of the bone marrow, which, depending upon the dose applied, may be transitory or may result in complete aplasia. The processes leading to depletion could be followed *in vitro* through the consecutive stages and a quantitative relationship between the doses applied and the resulting effect on the bone marrow could be established. The studies on the irradiated bone marrow cultures give decided proof of the remarkable destructive power of the roentgen rays on the bone marrow cells and show that the regressive changes in hemic cells are due to the direct effect of irradiation. These studies also suggest that the radiosensitivity of hemic cells is not determined by their belonging to a definite cell variety but by the developmental stage of a given cell and that it is intimately related to its mitotic activity.

The results achieved in experiments *in vitro* can be applied only with limitations for the understanding of the processes taking place in the living body. The culture represents a model which enables us to ob-

serve and to follow the fundamental phenomena resulting from the *direct* effect of roentgen rays on hemic cells. It is most probable that the mechanism involved in the response of bone marrow to roentgen rays *in vitro* plays an essential role also in the realization of the roentgen-ray effect *in vivo*. A direct effect of roentgen rays on the marrow cells may not, however, be the only factor which determines the response of the bone marrow to irradiation in the organism. The conditions in the animal body are certainly of a much more complex nature than those prevailing in the culture, and the changes produced by roentgen rays *in vivo* are presumably due "to a combination of direct and indirect damage to the blood forming organs" (Dunlap<sup>14</sup>).

#### SUMMARY

The direct effect of roentgen rays on rabbits' bone marrow cultivated *in vitro* was investigated. The doses applied ranged from 250 to 5,000 r.

The report is concerned with the changes in mitotic count of hemic cells, the retrograde cell alterations and the resulting effect on the cellularity of the irradiated bone marrow.

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# FIBROUS DYSPLASIA OF BONE\*

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**F**IBROUS dysplasia is the term at present applied to a group of cases which in the past have been designated by a variety of names. The bone lesions are characterized by one or more of the following features: broadening or expansion of the cortex; thinning of the cortex by encroachment from the medullary side; trabeculation which suggests cystic change, when as a matter of fact true cystic changes seldom exist; a fine ground glass appearance in the medullary portion of the shaft of affected long bones. This last change is most apt to occur in monomelic involvement and the distribution and limitation of the medullary changes have been said to resemble a melted tallow candle.

The lesions begin to develop during childhood or adolescence but may not be discovered until adult life. A single bone may be affected but more than one bone is apt to be involved. The lesions are usually, but not always, located on the same side of the body and may be restricted to a single limb. The condition is thought by most authorities to represent a skeletal developmental anomaly.

A number of terms have been applied to these cases. Lichtenstein and Jaffe<sup>12</sup> found thirty-three titles used to describe these cases in the literature. The titles used indicate that many authors sought to connect these cases with some established syndrome by using such terms as focal, unilateral or disseminated osteitis fibrosa or osteodystrophia fibrosa. Others have used such terms as regional or unilateral Recklinghausen's disease or regional or unilateral fibrocystic disease of bone.

When the syndrome is fully developed and is recognized early in childhood its significance is usually appreciated. In this age group the cases usually show severe

skeletal manifestations, and extrasketal changes consist of pigmentation of the skin, hyperthyroidism and in females precocious sexual development and premature skeletal growth and maturation. The extrasketal changes seldom occur in mild cases.

It is thought that many roentgenologists and other medical men do not appreciate the fact that comparatively mild cases of this disorder are encountered fairly frequently. While several bones are usually involved, cases may be seen where only one bone shows changes. Single lesions are frequently mistaken for some other pathological condition, most frequently fibrocystic disease.

On the radiological service of a general army hospital 4 cases of fibrous dysplasia of bone, which were confirmed by biopsy, were encountered between October, 1942, and October, 1945. A number of other cases were seen in which the roentgenograms suggested a diagnosis of fibrous dysplasia but in which a biopsy was not obtained. While the clinical roentgenologic and biopsy findings are indispensable in establishing a correct diagnosis, the roentgenologist is apt to see the case first and be able to suggest the correct diagnosis.

The cases which we saw were all in males in spite of the fact that approximately one-fifth of the cases seen on our service were females. Lichtenstein and Jaffe<sup>12</sup> in their survey of the literature found that almost 60 per cent of the reported cases occur in females.

Lichtenstein,<sup>11</sup> in reviewing the reported cases, found that the long bones of the extremities are most often involved, the order of frequency being femur, tibia, humerus and radius. Other bones which are often involved are the skull, pelvis and

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ribs. Lesions have been reported in the scapula, clavicle, vertebra, metacarpals and fibula. The widespread location of these lesions suggests that involvement in almost any bone might be anticipated.

#### PATHOLOGY

A detailed discussion of the gross and microscopical pathology in these lesions is not within the scope of this paper. Reference is made to the bibliography, particularly the presentation of Lichtenstein and Jaffe.<sup>12</sup> The gross finding is essentially a replacement of bone by fibrous tissue. This fibrous tissue, especially that occupying the medullary cavity in long bones, has a putty-like, gritty consistency. It may contain nests of cartilage and usually contains spicules of bone. Some areas may be cellular and may contain immature small spindle cells. Other areas are apt to show connective tissue that is poorly cellular and highly collagenous. Still other areas may appear edematous or myxomatous. Very occasionally a degenerative cystic change may be noted. Blood vessels are usually sparse and thin walled. Small lymphocytes and mononuclears may be found, usually infiltrated in the stroma surrounding the blood vessels.

Since this paper is concerned with cases showing relatively mild bone changes, none of which presented extraskeletal changes, the reader is referred to the literature for a full discussion of such changes. Pigmentation of the skin may occur in either male or female patients but from reports in the literature, the pigmentation that occurs in females is more marked. Premature sexual development and premature skeletal growth and maturation have been reported only in females. None of our patients showed any of these changes. Hyperthyroidism occasionally occurs in children of either sex. Our one juvenile case did not show any evidence of hyperthyroidism.

#### DIFFERENTIAL DIAGNOSIS

Erroneous diagnoses include "cystic disease," hyperparathyroidism, Reckling-

hausen's disease and Ollier's disease. Paget's disease, malignant bone lesions and Hand-Christian-Schüller's disease are usually less confusing in making a differential diagnosis.

Hyperparathyroidism can usually be excluded by careful consideration of the bone changes and the distribution of the lesions if they are multiple. In case of doubt blood chemical studies should clarify the diagnosis. In hyperparathyroidism there is an increase in the blood calcium; a decrease in the blood phosphorus; a marked increase in the phosphatase; and an excessive excretion of calcium in the urine, when the patient is on a low calcium diet. In fibrous dysplasia the blood calcium usually has a top normal value, the blood phosphorus is normal, the serum phosphatase is moderately increased and the calcium excretion is normal.

Skeletal enchondromatosis (dyschondroplasia or Ollier's disease) might be termed a cousin of fibrous dysplasia since it, too, is a skeletal developmental anomaly and its distribution is frequently unilateral. Helpful points in differentiating fibrous dysplasia from skeletal enchondromatosis are that fibrous dysplasia usually develops in childhood and not in infancy; usually has no gross lesions in the metacarpals, metatarsals or phalanges; and has less shortening of the affected long bones. The biopsy will readily distinguish the lesions in doubtful cases. While small cartilaginous islands are occasionally seen in fibrous dysplasia the basic microscopical picture is one of fibrous tissue replacement of bone in which spicules of immature bone are developed.

#### PROGNOSIS AND TREATMENT

The disease develops slowly, usually starting in childhood but often not being discovered and recognized until adult life. It is progressive and not self limited, as bones are never restored to their normal state. In older cases the progress of the lesions seems to cease and the disease becomes static. There is no known curative therapy. Such complications as fractures



require surgical treatment but elective surgical procedures are usually not indicated. Healing is slow and replacement is by the same type of fibrous tissue. Small doses of roentgen radiation have been suggested but no reports could be found in the literature. Observation of cases treated by roentgen radiation would have to be continued over a period of many years before an evaluation of results could be made.

#### REPORT OF CASES

CASE I. E. H., white male, aged eighteen, came for a roentgen examination and consulta-



FIG. 1. Case I. There is expansion of the bone cortex, trabeculation, bone absorption and bone production.

tion as an inductee. At the age of sixteen he had pain over the ischium following a minor injury. When this pain persisted for several weeks a roentgenogram revealed a lesion of the ischial tuberosity which showed expansion of the cortex and trabeculation of the involved bone with the intervening spaces fairly homogeneous in density. A biopsy done at that time showed fibrous tissue strands and soft fibrous tissue. A tentative diagnosis was made of "cystic disease."

At the time we saw the case almost two years later, the lesion had increased in size approximately 50 per cent. There was moderate pain on extreme exertion. A skeletal survey of the principal bones did not reveal any other lesions. Laboratory studies including blood calcium, blood phosphorus and blood phosphatase were all normal and were consistent with a diagnosis

of fibrous dysplasia. An additional biopsy was not obtained.

We feel justified in including this case as an example of fibrous dysplasia involving a single bone. The original diagnosis from the needle biopsy is one that is frequently made on early or single lesions of fibrous dysplasia.

CASE II. S. A. L., white male, aged twenty-nine, during the past ten years has noted a



FIG. 2. Case II. There is an expansile lesion of the proximal three-fourths of the shaft of the tibia associated with trabeculation and bone absorption and bone production.

vague heavy feeling in the right leg and a sensation of this leg being exceedingly tired following unusual or sustained exercise. During this time he also noticed gradual enlargement of the right shin bone. There was never any real pain.

On January 4, 1944, he experienced pain following a 3 foot downward jump on an obstacle course. The pain continued and the following day a roentgen examination revealed a pathological fracture in the proximal portion of the shaft of the tibia. The roentgenograms also revealed an expansile lesion of the proximal three-fourths of the shaft of the tibia associated with decalcification, trabeculation and slight bowing.

The blood calcium, blood phosphorus, blood

phosphatase and the calcium secretion were normal. The blood count, Kahn test and urinalysis were normal.

A biopsy was taken from the middle of the shaft of the femur February 24, 1944. The pathological report by Lt. Col. Harold L. Stewart was summarized as follows:

The specimen consisted of approximately twelve fragments of bone the largest of which measured 1 cm. in diameter. Microscopical sections showed small fragments of compact and membranous bone. Their margins were rough and sharp. There was evidence of bone formation and of bone destruction with osteoblasts and osteoclasts respectively. The spaces between the bone were occupied by edematous fibrous tissue containing a fair number of hyperemic capillaries. There were areas of hemorrhage and one or two foci of small round cell infiltration. No cysts were seen. In the sections of compact bone some of the haversian systems were distended with edematous fibrous tissue of the type just described. Between the peripheral limits of the haversian systems the bone was rather cellular and the cells were surrounded by clear spaces. The diagnosis was fibrous dysplasia of bone.

The opinion of the Army Medical Museum was that the lesion represented a true bone cyst. However, the clinical history, the roentgen findings and the microscopical findings are all consistent with the diagnosis of fibrous dysplasia of bone.

The pathological fracture healed slowly and the fracture line was not completely filled at the end of four months. No corrective surgical procedures were indicated.

**CASE III.** W. L. D., colored male, aged twenty-four. During a routine roentgen examination of the chest in June, 1943, the right fourth rib was found to show expansion of the cortex, trabeculation and areas of bone absorption. The entire rib was involved. Following discovery of the lesion, the patient complained of vague pain which was more marked after any unusual exertion. In February, 1944, the patient was admitted to our hospital for study and advice regarding therapy.

Roentgen examination showed the tumor involving the entire right fourth rib as described above. The Kahn test, blood count, temperature, urinalysis and sedimentation test were normal. The blood calcium, blood phosphorus,

blood phosphatase and the calcium excretion were also normal.

A biopsy was done February 25, 1944. The bone was soft, the cortex was firm in some areas and the subcortical area was composed of gray-brown gritty material. Microscopical sections showed edematous or hyalinized connective tissue, osteoid tissue, membranous bone and foci of cartilage which contained areas of ossifi-



FIG. 3. Case III. There is expansion of the cortex of the rib, trabeculation and bone absorption.

cation. At the periphery of the rib the bone varied considerably in thickness. In some areas it appeared to be of the compact variety but elsewhere it was thin and membranous. The bone spaces in the compact areas were distended to varying degrees with plugs of connective tissue. In some areas the histologic structure resembled callus, which raised the question of previous pathological fracture. The bone surface was irregular but the periosteum did not appear thickened. Much of the remainder of the various specimens was composed of fibrous tissue in which there was considerable bone formation and some bone destruction. There were numerous osteoblasts and osteoclasts. The new bone was of the membranous type, irregular in size and shape and



FIG. 4. Case IV. There is thinning of the cortex of the femur by encroachment from the medullary side, bowing and partial obliteration of the medullary canal.

often consisting only of soft osteoid tissue. In the scar tissue there were numerous scattered areas of granulation tissue. No cyst formation was seen. Most of the osteoid tissue did not show calcification. The areas of granulation tissue showed small round cells, plasma cells and histiocytes containing yellowish-brown granular pigment. The areas contained a few proliferating capillaries and a few small focal hemorrhages. The surrounding dense scar tissue contained a number of large hyperchromatic polygonal and rounded cells resembling bone

cells. These were fairly regular in appearance and stained heavily. The nucleus often showed a distinct acidophilic nucleolus and occasionally there were mitotic figures. These cells are not suggestive of malignancy. The diagnosis was fibrous dysplasia of bone with foci of granulation tissue, osteoid tissue and calcifying cartilage. The Army Medical Museum concurred in the diagnosis.

CASE IV. R. A. M., white male, aged twelve, entered the hospital in March, 1943, for diagnostic studies. He first noticed pain in the right thigh in September, 1942, and developed a limp about this time. These symptoms have persisted and the limping has become more marked. Physical examination revealed thickening of the right tibia, slight anterior bowing of the right femur and 1 inch shortening of the right leg. There was no limitation of joint motion and no atrophy of the musculature. Roent-



FIG. 5. Case IV. There is thinning of the cortex of the tibia by encroachment from the medullary side, obliteration of the medullary canal in the middle portion of the tibia and the fairly homogeneous density occupying the medullary canal which has been described as having the appearance of a melted tallow candle.

genograms showed similar changes in the right tibia and femur. There was thinning of the cortex by encroachment from the medullary side, bowing of both the tibia and the femur and obliteration of the shadow normally cast by the medullary canal. The medullary canal was filled by a fairly homogeneous shadow, its appearance suggesting a melted tallow candle. Roentgenograms of the other bones of the body showed no abnormalities. The roentgen diagnosis was polyostotic fibrous dysplasia.

The tuberculin test and the urinalysis, including the test for Bence-Jones bodies, were negative. The blood count, the Kahn test and the sedimentation rate were normal. The blood calcium, blood phosphorus, blood phosphatase, blood cholesterol and the cholesterol esters were all within normal limits.

On March 18, 1943 a biopsy was taken from the middle third of the right tibia. The cortex of the bone was thinner than normal. The subperiosteal surface of the bone cortex was fairly smooth. The endosteal surface was slightly rough and loosely attached to the osteoid-like tissue which filled the marrow cavity. The material which filled the marrow cavity was grayish-red in color, gritty and of putty-like consistency. There was no gross evidence of cyst formation.

Microscopical sections showed that the material filling the marrow cavity was composed of membranous bone enclosing spaces which were filled with soft fibrous tissue and a number of large endothelial lined blood channels. No cyst formation was observed. No normal bone marrow remained. Distributed along the margins of the bone trabeculae were numerous osteoblasts and osteoclasts and there was evidence of bone absorption and of bone regeneration. The fibrous tissue was cellular and moderately vascular being composed of spindle shaped and stellate cells having pale elongated nuclei and fibrillar cytoplasm. There are small foci of osteoid tissue and calcific spicules in this fibrous tissue. No cartilage was seen. There was no necrosis, no evidence of any inflammatory reaction and no evidence of malignancy..

The microscopical diagnosis was fibrous dysplasia of bone consistent with the roentgen diagnosis of polyostotic fibrous dysplasia. The Army Medical Museum concurred in the diagnosis.

#### SUMMARY

1. Fibrous dysplasia of bone is briefly

discussed. Attention is directed to the fairly frequent occurrence of lesions involving one or a few bones in which the symptoms are comparatively mild.

2. While the underlying etiology is unknown, the condition is thought by most workers to represent an anomalous skeletal developmental defect. It usually starts in childhood and develops slowly, often being recognized only during adult life.

3. The bone changes as recorded on the roentgenogram are suggestive and in some cases are diagnostic. The final diagnosis is best made after careful consideration of the roentgen and clinical findings and correlation of these findings with the biopsy studies.

4. Lesions usually involve several bones but may be restricted to one bone. Involved bones are apt to be on one side of the body but may be on both sides.

5. Extrasketal changes occur as a rule only when the bone changes are marked. While skin pigmentation occurs in males it is apt to be more pronounced in females. The precocious sexual development and premature skeletal growth and maturation seem to occur only in females. Hyperthyroidism may occur in either sex.

6. The disease is slowly progressive but may reach a static stage in adult life. Life expectancy is not influenced.

7. No curative therapy is known. Elective surgical procedures should usually be avoided as new bone is laid down very slowly and frequently does not occur.

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#### DISCUSSION

DR. AUBREY O. HAMPTON, Washington, D. C. This subject seems to me to be important for the same reason Dr. Bogart mentioned, that you may mistake it for something that needs radical surgery. I think it is one of the easiest diagnoses in radiology. The characteristic finding is that of a cystic appearing lesion which is usually expansile, but instead of having a radiolucent center it is more dense than could possibly be expected of a fluid-filled cyst. This is due to millions of partially calcified microscopic bone spicules in a matrix of fibrous tissue. This produces the same effect as if all bone architecture had been smudged by a thumb.

The margins of the lesion are increased in density but do not have sharp peripheries, except at the cortical margins, and even there the cortex may be destroyed; they fade off into adjacent bone in a streaming fashion which has been compared to the appearance of a candle flame. This feature allows differentiation from

enchondroma which may otherwise closely simulate fibrous dysplasia.

Cystic disease of hyperparathyroidism can be differentiated on the basis of generalized osteoporosis, which must be present if a diagnosis of hyperparathyroidism is to be made on the basis of bone lesions.

Simple bone cysts do not contain calcium—neither do giant cell tumors unless they have been interfered with.

One other feature of the calcification in fibrous dysplasia which should be mentioned is its usual homogeneous character. A myeloma may likewise simulate fibrous dysplasia but does not produce new bone.

It is unfortunate that confusion regarding the diagnosis is fibrous dysplasia has existed. This, of course, is the reason Dr. Bogart wrote his paper.

We saw a large number of patients with fibrous dysplasia in the Army; most of them were sent in with the mistaken diagnosis of hyperparathyroidism. Fibrous dysplasia seems to be a disease of young people, although it occurs in any age group.

Drs. Wyatt and Randall accumulated a number of cases in the Army and plan to publish them in the near future.

DR. FRANK WINDHOLZ, San Francisco, Calif. The diagnostic segregation of cases of fibrous dysplasia from hyperparathyroidism is indeed not difficult. We have only to consider that the flow of calcium from the bones into the blood stream in hyperparathyroidism occurs from all bones in equal intensity. This causes diffuse demineralization of the skeleton. Cystic changes of hyperparathyroidism develop in diseased, demineralized bones; those of fibrous dysplasia in normal appearing bones. The blood chemistry expresses these basic differences with the same clarity as do the roentgenograms. Blood findings are normal or almost normal in fibrous dysplasia in contrast to the well known profound disorders of calcium-phosphorus metabolism in hyperparathyroidism.

A second point I would like to bring out is the frequent involvement of bones of the skull in fibrous dysplasia. This knowledge is important not only because of the remarkable morphology of the changes but also because abnormalities of the skull in fibrous dysplasia were frequently confused with bony reactions of meningiomas and gave indications of surgical instrumentation.

In advanced cases of fibrous dysplasia in which there is 100 per cent involvement of the skull, marked deformities may occur with obliteration of the base and of the paranasal sinuses and with disfiguration of the face. These cases have been frequently published as leontiasis ossea. As a matter of fact, fibrous

dysplasia is the most frequent, but not the only cause of leontiasis ossea, but most of the cases of the last century and many of the past decades have been published with the denomination of leontiasis ossea. They were, in fact, fibrous dysplasia of the skull.



# THE TREATMENT OF CANCER OF THE BLADDER BY RADIUM NEEDLES\*

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TREATMENT of cancer of the bladder in or about the trigone is influenced by the accessibility of the cancer and the ability of the patient to support radical therapy. The resistance of debilitated cachectic patients is insufficient to tolerate the treatment, be this by total cystectomy or intensive roentgen or radium therapy. The efficiency of these local forms of therapy is limited to the area which is adequately treated, and they usually fail, if the cancer has extended through the bladder wall or has metastasized. The surface extent and especially the invasiveness of the cancer strongly influence its spread. In a recent study of 107 infiltrating cancers of the bladder autopsied at the Johns Hopkins Hospital, Jewett and Strong place the potential curability rate at 100 per cent, 86 per cent or 26 per cent, depending on whether the cancer is limited to the submucosa, has invaded the muscularis, or has penetrated through it. Fulguration through the cystoscope or cystostomy opening may suffice for an easily accessible fungating carcinoma but not so if there is a deep infiltrating base. In roentgen and radium therapy a zone of clinically uninvolved bladder wall varying in extent with the surface size and invasiveness of the growth has to be included in the treated area in order not to exclude unrecognized extensions; otherwise the treatment may be followed by persistence or recurrence of the cancer at the periphery of the treated area. Unrecognized spread of tumor beyond the adequately treated zone probably accounts for most of the failures in which treatment does not comprise the entire bladder.

Partial resection may suffice for epitheliomas of the lateral walls, but not for those

in or about the trigone. Total cystectomy is applicable to a small selected group of patients without tumor penetration of the bladder wall, and with a good risk that allows ureter transplantation and removal of the bladder in rapid sequence.

Roentgen therapy through a cystostomy opening, with 45 kv. or higher voltage, is handicapped by the difficulty of adequately irradiating large tumors, because of the limited field of irradiation when a narrow roentgen-ray cone is placed in the bladder.

The tumor dose delivered by external roentgen therapy with 200 kv. is usually insufficient to destroy cancer of the bladder. Thus Herger and Sauer did not see complete disappearance of this growth, following a tumor dose of 4,300 r, administered through two anterior and two posterior pelvic fields, 200 kv., 0.9 mm. Cu, 80 cm. target skin distance and 150 to 400 r per day. Attempts to raise the depth dosage of roentgen radiation at 200 kv. by increasing the size and number of radiation fields have not been well tolerated, because of inclusion of large volumes of uninvolved tissues.

Supervoltage has been used in place of 200 kv. in order to overcome this shortcoming. This permits the administration of a better tumor dosage without endangering the tolerance of the patient. Fibrosis and other injuries of the rectum and pelvic tissues may be avoided by appropriate prolongation of the treatment time and accurate dosimetry. Buschke and Cantril report 10 of 68 patients thus treated with 800 kv. clinically well, 7 of them for four years. They state that prerequisites for successful treatment, in addition to properly administered and sufficient dosage,

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are adequate bladder drainage and capacity, absence of marked infection and no preceding cystostomy—as the suprapubic scar might break down if intensively irradiated. They believe that the entire bladder should be treated, as attempts to limit the irradiation to the clinically involved portion frequently have resulted in persistence of the cancer at the periphery of the treated area. Careful cystoscopic control before and after treatment is imperative.

Cystoscopic implantation of radon seeds may occasionally be satisfactory for small accessible papillary carcinomas. For more extensive or infiltrating types this approach is too inaccurate, and exposure through cystostomy is necessary. Suprapubic cystostomy permits better visualization and palpation of the tumor, more precise outlining of its limits, and more accurate distribution of the seeds. Even after the bladder has been opened, however, one may underrate the size of the involvement, especially in large tumors, and choose inadequate radiation fields. In the experience of Herger and Sauer, for instance, interstitial implantation of radon seeds or radium needles has been unsatisfactory in cancers the diameter of which was greater than 5 cm. The result, of cystoscopic implantation, insertion through cystostomy, and a combination of both methods, is illustrated by Barringer's statistics. Twenty-one of 257 patients treated by him with gold seeds remained well for ten years. The seeds were inserted through a suprapubic cystostomy wound in 183, combined with cystoscopic implantation in 85, and limited to cystoscopic treatment in 89. The cancers were 10 cm.<sup>2</sup> in 138 of the 235 in which the size of the lesion was known; they were 2 to 10 cm.<sup>2</sup> in 92 and less than 2 cm.<sup>2</sup> in 5.

Radon needles may, because of their longer focal lengths, be placed more accurately than the shorter seeds in thick and extensive cancers. In contrast to the seeds abandoned in the bladder wall, needles are withdrawn after their use, and no foreign body is left to slough into the bladder. If element is employed the rate of irradiation

is even and not as intense as with seeds, in which one-half of the entire dose is given in the first four days. The trauma of inserting and later removing the larger needles, however, is greater than with seeds. Personal experience plays an important part in determining the preference for the one or the other method.

Successful treatment depends on an adequate field of irradiation which must include a zone of clinically uninvolved bladder. The needles should be distributed in accordance with the physical dosage laws governing interstitial irradiation. This is not always possible, because of the great depth of the operative field. The facility for accurate placement of needles, and consequently of the results, is likely to improve with increasing experience. In order to combat the tendency to ascending pyelitis at the time when the irradiated mucosa is sloughing, chemotherapy and continuous suction is of great value.

According to Cade, a dose of 8,000 gamma roentgens ( $r_r$ ) in nine to ten days is necessary to control cancer of the bladder by radium needles. When he used 3,000–5,000  $r_r$ , only non-infiltrating, papillary cancers were controlled. He emphasizes the need for slow irradiation, 35–45  $r_r$  per hour, in order to avoid radium burns while administering doses of this magnitude. From this point of view, radium element needles would be preferable to radon seeds.

The experience at the Presbyterian Hospital, New York, has been similar to that of Cade. Since the hospital purchased radium needles in 1931, members of the radiological and urological services jointly have treated over 100 cases of bladder cancer by suprapubic cystostomy and implantation of radium element needles.

After exposure of the tumor by cystotomy in the usual manner, the radiotherapist who up to this time acts as second assistant, changes position with the operator and implants the first row of needles. These are inserted into the muscularis, under the tumor from above down towards the bladder neck including 2 or 3 cm. pe-



ripheral to the tumor, depending on its size and invasiveness. If practicable, additional needles are placed at right angles to and across the non-radiating points and eyes of the first row, in order to raise the low radiation intensity in these areas. If the point of a needle is inadvertently pushed through the bladder wall, it is withdrawn and reinserted correctly. We have not seen any serious consequences resulting from this error.

The needles are the common 0.5 platinum irridium variety with a 0.5 cm. solid point and double eye, for two heavy twisted silk threads. These are used to pull the needles out after a sufficient dose has been administered. The needles most commonly have an overall length of 3.2 cm., more rarely 3.7 cm., have a focal length of 2 or 2.5 cm., and a corresponding radium element content of 2 or 2.5 mg. Thus, each needle delivers 48 to 60 mg-hr. every twenty-four hours. Accurate placement and distribution of needles require a good exposure and a dry field. The blades of the self-retaining bladder retractor should be spread as widely as possible, and moved around to such a position as not to cover any part of the tumor or adjacent mucosa into which needles will be inserted. It is preferable to obtain a biopsy via the cystoscope a few days before the cystostomy. Superficial fulguration of fungating masses has in our experience not facilitated the treatment. On the contrary, occasionally it seems to have increased the likelihood of immediate bleeding and of subsequent bleeding or subsequent fever from absorption of the destroyed tumor. We prefer not to fulgurate the tumor at the time of the cystostomy, unless the base can be adequately coagulated if pediculed—otherwise we rely only on treatment with needles. After the needles have been inserted, a diagram is drawn recording the position of the needles in the bladder; this permits calculation in gamma roentgens and thus determines the length of time the needles should be left in situ. Failure of the treatment is attributa-

ble chiefly to inadequate fields or underdosage.

The threads of the needles are tied into a bundle leading out of the wound. The tumor and needles are covered with a gauze pack to increase the distance between the opposite bladder wall and the radium and to protect the needles from dislodgment. This gauze is allowed to protrude through the bladder wound. The Freyer tube is inserted into the bladder; the space of Retzius drained, and the wound closed. The needles remain in situ for five to seven days, depending on the dose desired. The rubber tissue drain in the space of Retzius and the gauze pad in the bladder are then taken out and the needles removed. It is best to have the diagram on hand so as to know in which direction to pull. Among more than 100 cases treated during the past fifteen years we have had only one case in which the string tore loose and it became necessary to remove the needle by reopening the bladder. The silk threads should be fresh, because those that have remained in the needles while stored in the safe, for several weeks, are apt to be brittle.

Immediately after getting back to bed the patient is started on continuous bladder suction which is kept up until the acute radiation reaction has subsided. After removal of the Freyer tube a metal disk is inserted and suction is continued. After two or three weeks the cystostomy opening is allowed to close.

Between 1931 and 1941 we treated with radium needles 46 patients with microscopically proved cancer of the bladder. The results of this treatment are given in Table I, II, III, and IV.

As seen in Table I the clinical recurrence of bladder cancer in cases which have not been arrested usually manifests itself during the first or second year after treatment. This should be suspected when symptoms of cystitis, hematuria and ulceration reappear within that time. The area should not be retreated by radium needles, however, unless microscopical examination shows persisting carcinoma. *Non-healing radio-*

TABLE I

TREATED 1931-1941; REVIEWED MAY, 1946

Patients treated, total number	46
Died of pneumonia, coronary disease, free from cancer 2-4 yr. after treatment	2
Used for this report	44
Dead of cancer:	34
25 in 1 yr., 8 in 2 yr., 1 in 3 yr.	
Dead in 15 yr. of perinephritic abscess, free from cancer at postmortem examination	1
Now alive and clinically free from cancer 5-15 yr.	9

*necrotic ulcerations may develop within this period or after it, which cannot, grossly, be differentiated from recurring cancer.* The occurrence of radionecrosis is more frequent in ulcers with a diameter larger than 5 cm. in which the center is poorly nourished. A bladder stone may form in such locations. The patient listed in Table I who died of perinephritic abscess fifteen years after treatment with radium needles illustrates these points.

The diameter of the original ulcer was 5.5 cm. A large bladder stone formed at this site and was removed three and one-half years after treatment. An ulcer was seen at the old site eight years after treatment. Biopsy was equivocal. Nevertheless it was thought best to give some roentgen therapy. The dosage was 1400 r/o through each of two anterior and two posterior 10 by 10 cm. pelvic fields with 200 kv., 1 mm. Cu. filter and 50 cm. target skin dis-

TABLE II

EXTENT AND SURVIVAL

	No. Treated	No. Free from Cancer
Extension outside bladder	10	0
Involved ureters	10	1
Moderately deep ulcer	10	1
Deep ulcer	7	1
Two or more tumors	4	1
<i>Estimated size of single tumors</i>		
5 cm. <sup>2</sup> or less	1	1
6-10 cm. <sup>2</sup>	6	2
Over 10 cm. <sup>2</sup> to 25 cm. <sup>2</sup>	22	4
Over 25 cm. <sup>2</sup>	11	2

TABLE III

MICROSCOPIC CLASSIFICATION AND SURVIVAL  
IN 44 PATIENTS

	No. Treated	No. Free from Cancer 5 years
Papillary (Grades 1 and 2)	10	4
Papillary infiltrating (Grades 3 and 4)	15	3
Infiltrating non-papillary	13	1
Infiltrating non-papillary (squamous metaplasia)	6	2

tance. The inadequacy of the tumor dose from such surface dosage needs no discussion. The patient's wound broke down twelve years after treatment, and it was thought he was going to die of his "recurrence". At postmortem examination no evidence of cancer could be found anywhere. The patient had died of a perinephritic abscess secondary to the old ulcerated shrunken bladder.

As noted in Table II, the extensiveness of the cancer is the most important factor in reducing the likelihood of a cure. The gravity of involvement of the ureters is worthy of note. The progressive diminution of curability rate with increasing size of the lesion is self-evident and should spur physicians not to delay cystoscopy, as only then can the early small cancer be discovered and treated.

Table III demonstrates the greater the accessibility, the less likelihood of early wide spread within the bladder wall and outside of the bladder, and consequently the superior results in papillary non-infiltrating and infiltrating as compared to

TABLE IV

SURVIVAL AND DOSAGE IN 40 SINGLE TUMORS

	No. Treated	No. Well 5 years
Less than 5,000 r <sub>y</sub>	5	1
5,000 to less than 7,000 r <sub>y</sub>	11	1
7,000 to 8,000 r <sub>y</sub>	8	2
Over 8,000 r <sub>y</sub>	16	5



FIG. 1. Papillary epithelioma, Grade 2. Large cells with big deep-staining nuclei. The base showed invasion.

non-papillary epitheliomas of the bladder. The microscopic appearance of these four types can be seen from the photomicrographs (Fig. 1, 2, 3 and 4).

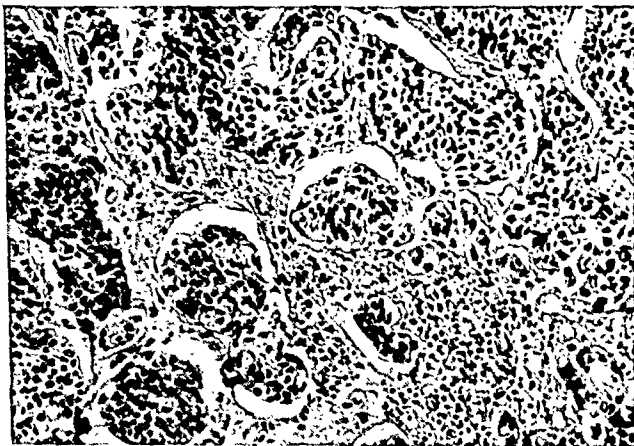


FIG. 2. Papillary infiltrating epithelioma, Grade 3. Masses of cancer cells infiltrating bladder muscularis.

Table IV leaves no doubt as to the desirability of administering an average dose of 8,000 gamma roentgens to cancers of the bladder treated by radium needles.

#### SUMMARY

Forty-four patients with microscopically proved cancer of the urinary bladder in or near the trigone were treated five to fifteen years ago with suprapubic cystostomy and implantation of radium needles. Thirty-

four died presumably of persisting or recurring cancer, and one died fifteen years after treatment, no cancer being found at autopsy. Nine patients are living, and appear

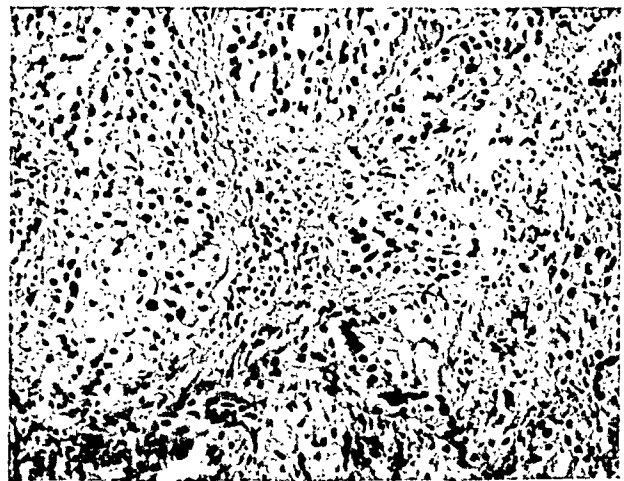


FIG. 3. Anaplastic epithelioma, Grade 4. Diffuse involvement of muscularis by atypical cells.

free from clinical evidence of cancer. Extensions outside the bladder wall and involvement of the ureters were signs of poor prognosis. Results were best in small



FIG. 4. Non-papillary infiltrating squamous cell epithelioma, Grade 3. Beginning epithelial pearl formation.

papillary tumors, though some of the larger infiltrating cancers responded well to the treatment. A tumor dose of 8,000 gamma roentgens seems preferable to smaller doses.

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## DISCUSSION

DR. FRANZ BUSCHKE, Seattle, Washington: Dr. Lenz asked me to say a few words in reference to our results with supervoltage roentgen therapy for carcinoma of the bladder in comparison to the material treated with interstitial radiation which he has just presented. A total of 66 cases was treated between 1934 and 1945 at the Swedish Hospital Tumor Institute. Out of 61 cases treated between 1934 and 1942 which have been followed for more than three and a half years after treatment, 9 are clinically and cystoscopically well to date; 1 for ten years; 2 for seven years; 1 for six years; 3 for five years; 2 for four years. From the analysis of the failures and of the successes we have come to certain conclusions as to the indications and contraindications of roentgen therapy for different types of carcinoma of the bladder. As far as indications are concerned, we find that the suitable type of bladder carcinoma is the papillary carcinoma of moderate or low degree of differentiation, prior to the invasion of the bladder wall. The prognosis becomes worse when the papillary growth has infiltrated the bladder wall. The demarcating line is probably the invasion of the bladder muscle. Invasion of the submucosa, as one case has taught us, can apparently still be controlled. In papillary growths that have infiltrated,

cystoscopic examination has shown that the papillary portion of the tumor disappears but that a recurrence originates from the remaining infiltration in the bladder wall.

Papillomas of very high degree of differentiation have not been influenced at all by massive roentgen therapy.

The single primarily infiltrating ulcerative epidermoid carcinomas are not suitable for this type of treatment and are in our opinion better treated by interstitial irradiation or surgical excision.

On the basis of these experiences, we therefore feel that the best type for roentgen therapy is the recurrent multiple or solitary papillary carcinoma of the bladder prior to invasion of the bladder wall. If these tumors recur after one or two fulgurations, it should be decided at that time which further course should be followed: repetition of fulgurations, cystectomy, or roentgen therapy.

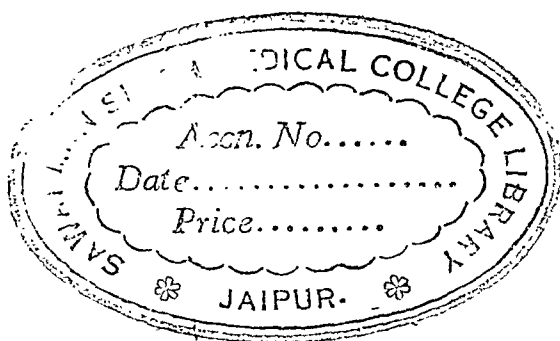
Radical roentgen therapy for carcinoma of the bladder is a formidable procedure and has its definite contraindications. We feel strongly that it is not useful as a palliative procedure. If there is no hope of control of the disease, roentgen therapy will rather add to the discomfort by increased necrosis with bladder frequency and pain. The treatment is supported only if the general condition of the patient is reasonably good, if there is no excessive infection of the non-tumorous portion of the bladder mucosa, if the drainage and capacity are adequate. In patients with inadequate drainage, the reaction is usually so intense following roentgen therapy that treatment is not supported and cannot be completed. If the treatment is forced under these conditions the general condition of the patient will decline following treatment very rapidly. We have therefore recently requested establishment of adequate drainage if it is necessary, by transurethral resection either of the obstructing prostate or the obstructing portion of the tumor.

DR. DOUGLAS QUICK, New York, N. Y. I feel that Dr. Lenz's approach is certainly basically very sound indeed, and I personally am definitely in favor of the weaker needle and slower irradiation. There is one question I should like to raise: that is, the probable advisability of roentgen irradiation in part, followed at an appropriate and safe interval by the element needle application rather than the

total irradiation by element needles alone. I refer to the same basic principle that Dr. Meigs brought out this morning on the use of radium in his cervix cases. He referred to a "half dose." By this he meant using half roentgen irradiation to reduce the bulk of tumor before his operative procedure in certain instances. That half dose will reduce the bulk of tumor. Will it permit of the lesser half of tumor being more efficiently irradiated by the element needles? I just raise that question for your opinion.

DR. LENZ (closing). I appreciate the suggestion of Drs. Quick and Bushke to combine roentgen radiation with interstitial implantation of radium in cancer of the bladder. When the opportunity presents itself, I may follow it.

Transurethral implantation of seeds through a cystoscope should be limited to very small papillary lesions as otherwise there is danger of inaccurate placement of seeds and consequent over-irradiation of some parts and under-irradiation of others.



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# E D I T O R I A L S

## THE ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Forty-eighth Annual Meeting of the American Roentgen Ray Society held at Haddon Hall, Atlantic City, September 16-19, 1947, can be looked upon as one of the best the Society has had in many a year. President J. B. Edwards and his Program Committee had arranged a splendid program from beginning to end, and it is doubtful whether the members of the Society have ever listened to a more interesting group of scientific papers than were presented at this meeting.

The meeting opened with the usual ceremonies: the Call to Order for the Forty-eighth Annual Meeting by President Raymond C. Beeler and his presentation of Scientific Exhibit Awards which were given at last year's meeting. Following this, the Society listened to a very interesting Address of Welcome by Dr. Royal A. Schaaf, President of the Medical Society of New Jersey. Following the Address of Welcome there was the Installation of President-Elect J. Bennett Edwards as President, and Dr. Edwards himself, in lieu of an address, gave some very timely advice regarding the practice of roentgenology in the smaller communities and towns. His remarks were as follows:

Friends of the American Roentgen Ray Society: I must take a moment of your time to express my appreciation to the members of the Society for their vote of confidence when they elected me to be President of this, the oldest roentgen-ray society in the Western Hemisphere. I am happy to accept the responsibilities and honors of this office.

I have spent nearly forty years in the practice of medicine in a suburban community on the western slope of the Palisades in the north-eastern part of the State of New Jersey within

three miles of the New York City line. The Hudson River separates us from New York. The George Washington Bridge permits us to cross the river in a couple of minutes. To the younger generation of roentgen-ray and radium workers who have not as yet arrived at a conclusion as to a site for their life work I would suggest that they give some thought to the selection of a rural center of population or a suburban center of population. Article 11 of the Constitution of our Society states. "The Object of The American Roentgen Ray Society shall be the advancement of the science of Radiology and its maintenance as a specialty in medicine." I feel confident that thoroughly trained roentgenologists and radiologists will find adequate compensation in the rural and suburban centers of population in return for their efficient and sympathetic radiological service, and will in this way extend the science of radiology and improve its position as a specialty in medicine. I believe many will also enjoy the life in these centers of population.

The Program Committee met in Atlantic City last October. I have attempted to follow their suggestions and recommendations. The program as you see it is due to the efficiency and secretarial accuracy of Dr. H. Dabney Kerr. The success of this meeting will be due to the work of these names which you will find in the printed program; The Essayists and Discussors of the papers; the Exhibitors; the Director of the Instruction Courses and his staff of experienced teachers. To each and every one of them I say "thank you."

Following this introductory speech the opening address was given by Dr. Ross Golden and Dr. A. Purdy Stout on "Superficial Spreading Carcinoma of the Stomach." This was a most interesting and instructive paper and will be published shortly in the JOURNAL.

The scientific program of the meeting

then continued with a Symposium on Pediatric Roentgenology. Several papers dealing with various aspects of pediatric roentgenology were presented by some of the outstanding roentgenologists of the country. The topics ranged from "The Roentgen Changes Produced by Diffuse Torulosis in the Newborn," to "The Roentgenological Diagnosis of Congenital Heart Disease"; "The Skeletal Lesions in Leukemia: Clinical and Roentgenographic Observations in 103 Infants and Children," and another paper on "The Significance of Triangular Hilar Shadows in Roentgenograms of Infants and Children." Unfortunately, one paper scheduled for this symposium, namely "Common Roentgenologic Findings in Chronic Pyuria," which was to be given by Dr. Meredith F. Campbell, had to be omitted because of the illness of the author.

On Tuesday evening the annual Caldwell Lecture was given by Dr. Merrill C. Sosman, a distinguished former president of the Society. Dr. Sosman was introduced by Dr. Arthur C. Christie and the Presentation of the Caldwell Medal to Dr. Sosman at the close of the lecture was made by Dr. James T. Case. Dr. Sosman gave a scholarly address on "Cushing's Disease—Pituitary Basophilism," covering its historical and its clinical and pathological manifestations, illustrating his lecture with numerous cases and lantern slides. The Caldwell Lecture is to be published in the JOURNAL.

On Wednesday morning one of the most stimulating symposiums ever presented before any society was given. This was a Symposium on the Lesser Circulation. It began with "The Anatomy and Physiology of the Lesser Circulation, as Indicated by Its Behavior in Health and Disease"; continuing, there were papers dealing with "The Roentgen Appearance of the Chest in Certain Diseases Affecting the Peripheral Vessels of the Lung"; "Congenital Cardiac Anomalies and Their Relation to the Lesser Circulation"; "The Clinico-physiological Approach to Lung Function." This last very thought-provoking paper covered such

topics as static tests of lung volume and its subdivisions; dynamic ventilation tests; gas diffusion; pulmonary blood flow studies, and the author, Dr. Robert D. Dripps, touched lightly upon some new investigations which are being made at his clinic having to do with new methods that have been applied to the dynamic study of cardiorespiratory function. Another paper dealt with "A Discussion of Conditions Which Result in Increased Pressure within the Lesser Circulation," and another with "The Evaluation of the Lesser Circulation as Portrayed by the Roentgen Film." This group of papers not only served to emphasize the tremendous progress which we are making in the study of the lesser circulation but it emphasized also the great importance such studies have in the interpretation not only of the normal but of the pathologic state, and this symposium indicated in its detailed and broad outlines the importance of further research and study in this particular field.

There was a stimulating group of papers dealing with "The Gastric Cancer Problem: Methods of Attack and Their Present Status"; "Carcinoma of the Stomach: Its Incidence and Detection"; "Pyloric Obstruction More Accurately Diagnosed by Barium-Food Mixture"; "Small Intestinal Motility in Acute Dysentery," and papers dealing with certain bone dyscrasias, namely "Monostotic Fibrous Dysplasia" and "Non-pathologic Variations in Relationships of the Upper Cervical Vertebrae."

The program was rounded out by incorporating a group of papers on radiotherapy among which were "The Possibilities of the Treatment of Malignant Tumors by Fast Electrons"; "Irradiation of Pituitary Tumors"; "Dosage Determinations with Radioactive Isotopes"; "Colloidal Lead Associated with Deep Roentgen Therapy in Bone Metastases"; "Chondronecrosis of the Larynx"; and a comprehensive paper on "Roentgen Treatment for Extensive Epithelioma of the Larynx" and another paper dealing with "Irradiation Injuries to the Urinary and Intestinal



Tract Following the Use of Low-Intensity Long Element Needles in the Treatment of Carcinoma of the Cervix Uteri"; "Post-irradiation Ulcerations of the Uterine Cervix"; and "Roentgen-Ray Therapy as an Inhibitor in the Recurrence of Urinary Bladder Carcinoma."

The mere listing of these thought-provoking discussions can give only a limited idea of the intense interest displayed by the audience in all these papers. There were thirty-four listed participants in the scientific sessions.

A detailed report of the scientific exhibits which were arranged by the Scientific Exhibit Committee under the chairmanship of Dr. R. A. Arens is given elsewhere in this issue of the JOURNAL. The Scientific Exhibit in its entirety can only be described by the word excellent, and to the Scientific Exhibit Committee the Society gives its grateful thanks. This scientific exhibit has never been surpassed and scarcely ever equalled.

One of the lodestones of every annual meeting is the Instruction Courses which have been so ably conducted throughout a number of years by Dr. B. R. Kirklin. The Forty-eighth Annual Meeting of the Society was no exception in the attraction of numerous radiologists who attended these Instruction Courses. To Dr. Kirklin who this year relinquishes his directorship of the Instruction Courses the Society expresses its deep and grateful appreciation for hours and weeks of laborious effort in arranging the Instruction Courses and also supervising the excellent manner in which they have been carried out at each of the annual meetings. It is with deep regret that the Society at his request relinquishes the services of so able a person not only in this capacity but in all capacities dealing with medicine and radiology. Of course the Society is always grateful to the instructors who participate in the Instruction Courses. They give of their time and efforts and it is only with their cooperation that these courses are of such great importance.

Atlantic City lends itself admirably to

the needs of a meeting place. Here one is isolated or rather insulated from the usual hubbub of traffic and other distractions from the proceedings of the Society. Atlantic City has hotel facilities, especially at Haddon Hall, which are unsurpassed, and if one needed any further proof of this, attention need only be called to the great numbers who registered at the annual meeting—there were over nine hundred registrants.

A list of the Technical Exhibitors who participated in this meeting is given elsewhere in this issue. To the manufacturers and their able representatives and assistants the Society expresses its thanks. Certain restrictions which obtained during the war having been removed, the technical exhibitors were enabled to display the newer features which have been devised during these last years and fortunately the accommodations of Haddon Hall were such as to enable the technical exhibitors to have sufficient space adequately disposed not only to make their displays attractive but accessible to all.

To the staff and personnel of Haddon Hall who contributed so greatly toward the success of the meeting in all respects, the Society expresses its thanks.

The two usual social events of the meeting were this year well arranged and much enjoyed by the participants. The annual golf tournament under the direction of the local chairman, Dr. Robert A. Bradley, was held on Monday at the Seaview Country Club. This consisted of an eighteen hole match for the Willis F. Manges Trophy and the Exhibitor's Trophy. The annual banquet on Thursday evening was unsurpassed not only by the splendid music and entertainment but all members of the Society and guests participated wholeheartedly in the gaiety of the occasion.

All in all, Dr. Edwards and those who arranged the program can look upon the Forty-eighth Annual Meeting with considerable pleasure in the knowledge that it was a job carefully arranged and splendidly executed.

## OSTEITIS PUBIS

**O**STEITIS PUBIS is a fairly infrequent complication of suprapubic prostatectomy. This condition was first described by Beer in 1924 and he later reported additional cases. Since Beer's initial report several cases of osteitis pubis following suprapubic bladder operations have been reported.

Quite recently Powell<sup>1</sup> reports an additional case, calling attention to the condition, the etiology of which is not known. Attempts have been made to reproduce the condition in rabbits experimentally, but without success.

The clinical course of the disease process is of importance in arriving at a diagnosis. The history of a recent suprapubic operation, with localized pain over the symphysis pubis, is sufficient, as a rule, to suggest osteitis pubis, and if roentgenograms are made in the second or third week a diagnosis is possible. The roentgenograms reveal a roughening or fraying of the periosteum and a moth-eaten appearance of the symphysis pubes and rami. Decalcification of the rami and inner portions of the ischia may become evident on subsequent roentgenograms. There may be some confusion in arriving at a diagnosis without the roent-

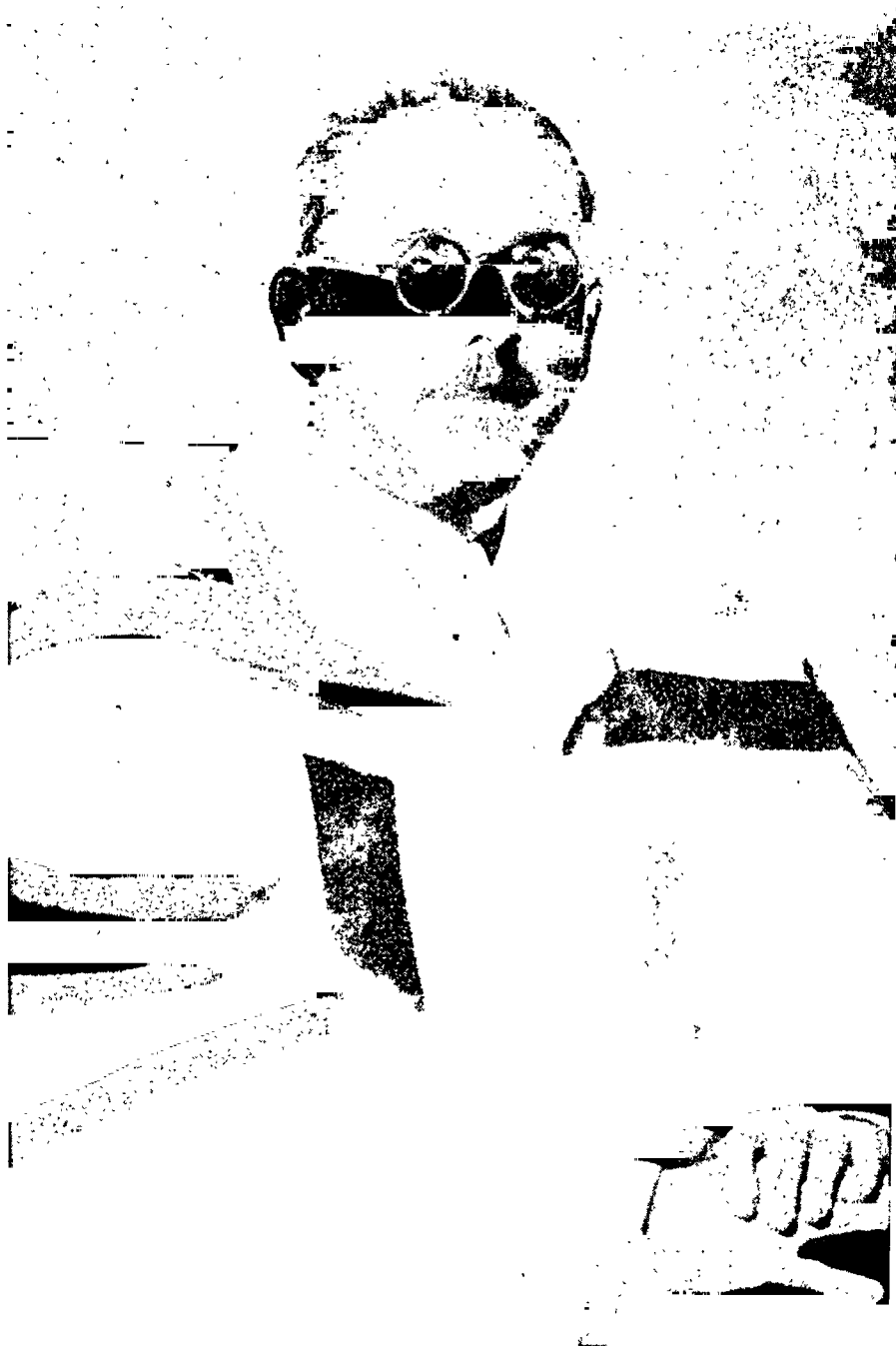
genograms as the condition in its clinical manifestations may simulate a simple infection of the space of Retzius or of one of the perivesical spaces. There is a possibility of confusing the changes in the symphysis with a frank osteomyelitic process of the pelvic girdle from some hematogenous infection, though if the roentgenogram is carefully analyzed there should not be too great difficulty in differentiating the two conditions.

The onset of the condition varies from a few days to two months after operation and is usually insidious, the patient experiencing a dull aching pain in the region of the symphysis pubis which may become localized either in the region of the right or left superior or inferior ramus. The pain may radiate to the perineal region and to the inner aspect of the thighs which occasions difficulty in walking and the patient may become completely bedridden as the pain becomes more excruciating, particularly when he attempts flexion or extension of the lower extremities. The duration of the condition is variable. Symptoms may persist for as long as six weeks to two years. Recovery is slow and tedious.

Roentgenologists should be familiar with the condition in order to avoid confusion in arriving at a proper diagnosis.

<sup>1</sup> Powell, N.B. Osteitis pubis. *J. Bone & Joint Surg.*, July, 1947, 29, 785-787.





ULYSSES SILVER KANN  
1873-1947

**D**R. ULYSSES S. KANN, a member of the American Roentgen Ray Society since 1918, died on April 7, 1947.

Dr. Kann was born in Neuchatel, Switzerland, February 28, 1873, and studied medicine at the University of Geneva. His thesis presented in 1901 for the doctorate

of the University of Paris, Mention: Medicine, is bound with several others for the doctorate in medicine. This difference in wording is a part of considerable evidence which implies that this thesis was for advanced work. In the avant-propos he mentions M. Le Dr. E. Kummer, as his former

chief; and he also identifies himself as "ancien assistant du Dr. Kummer, Chirurgien de l'Hopital Butini, à Genève"; and in addition, he had served as surgeon of Count Leontieff's expedition of 1898-1900 to Abyssinia.

The Paris thesis is a presentation of cases of conservative surgery on the Fallopian tubes, with a comprehensive review of the literature. It contains photographic evidence that it antedates the use of rubber gloves in laparotomies in Paris.

Directly after his graduation in Paris, Dr. Kann came to New York, and the state directory for 1901 lists him as on the staff of French Hospital. He was still a surgeon when in 1914 he chose life in a smaller city and moved to Binghamton, New York. However, Mrs. Kann tells me that he had become interested in radiology even in the early days in Paris. Thus just as his experience in surgery dates back to a very different epoch from the present, his interest in radiology dates back to an epoch when a thesis contemporary with his own (by Dr. Eugene Joüon) observes "Enfin, dans les cas où l'on hésitera il faudra recourir à la radiographie qui montrera, comme dans notre cas, la cavité cotyloïde déshabillée et la tête du fémur en avant et en dedans." Dr. Kann, who went to the Mexican border with the medical corps in the incident of 1916, entered the school of military radiology in New York commanded by Major L. T. LeWald. After completing the course he served for fourteen months at Camp Wadsworth, Spartansburg, South Carolina, where he established and was chief of the X-ray Department and attained the rank of Major. From there he was ordered overseas with Base Hospital No. 16 at Revigny, France. After

the end of the war he was in the Army of Occupation at Treves and Coblenz, Germany. In all, fourteen months at Camp Wadsworth and eight months overseas. After his discharge he returned to Binghamton where he gave up surgery for radiology and established the department in the Binghamton City Hospital, of which he was the chief until he retired from the hospital at the age of sixty-six. He remained in private practice until 1942. He served as president of the Broome County Medical Society, the Binghamton Academy of Medicine, and the Central New York Roentgen Society. He was also a fellow of the American College of Radiology and a member of the Radiological Society of North America.

Dr. Kann's retirement from practice was occasioned by the loss of his right leg from obliterating endarteritis. Despite the circulation in the other leg being rather precarious, he was able to get about enough to derive much enjoyment from life, and he used to say, "One of my legs gives me no trouble at all: the artificial one." About a month before his death, his coronary circulation became involved, and his last week was in Lenox Hill Hospital. His funeral, with military honors, was in the Church of the Epiphany.

Dr. Kann is survived by his wife, Mrs. Helen R. Kann, to whom he was married January 19, 1909. They lived at 1140 Fifth Avenue, New York, where she remains. They have a daughter, Mrs. Jeanne Farrell, and two grandchildren, in Easton, Pennsylvania; and a son, Paul Kann, who was recently appointed assistant professor of French at Simmons College in Boston.

RAMSAY SPILLMAN

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# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14-17, 1948.

#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Chicago, Ill., 1948.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Fortmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21-25, 1948.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### LOUISVILLE RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

## NEBRASKA RADIOLOGICAL SOCIETY

*Secretary*, Dr. O. A. Neely, 924 Sharp Bldg., Lincoln, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

## NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

## NEW HAMPSHIRE ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

## NEW YORK ROENTGEN SOCIETY

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

## NORTH CAROLINA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

## NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

## OHIO STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland. Meets during meeting of Ohio State Medical Association in Cincinnati, May, 1948.

## OKLAHOMA STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

## ORLEANS PARISH RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

## PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

*Secretary*, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

## PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

## PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport.

## PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

## PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

## PORTLAND ROENTGEN CLUB

*Secretary*, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

## RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary*, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

## RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

## RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

## RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

## RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, New-

ark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

## ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

## ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary*, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

## ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

## SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

## SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

## SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

## SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

## SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

## TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

## TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

## UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

## UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

## UTAH RADIOLOGICAL CONFERENCE

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

## UTAH STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

## VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

## WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University

Hospital, and second six months at Toland Hall, University of California Hospital.

#### CUBA

##### SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

#### MEXICO

##### SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

#### BRITISH EMPIRE

##### BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

##### FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

##### SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

##### CANADIAN ASSOCIATION OF RADIOLOGISTS

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

##### SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

##### SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

##### RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

##### SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

##### RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

#### SOUTH AMERICA

##### SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

##### SOCIEDAD PERUANA DE RADIOLOGIA

*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

#### CONTINENTAL EUROPE

##### SOCIÉTÉ BELGE DE RADIOLOGIE

*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

##### ČESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

##### POLISH SOCIETY OF RADIOLOGY

First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

##### WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

##### SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

##### ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

##### LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

##### MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamysgin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

##### SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

##### SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

##### SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary for French language*, Dr. Babaianz, Geneva. *Secretary for German language*, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

#### SCIENTIFIC EXHIBIT

The Scientific Exhibit, which is always an important and instructive contribution to the annual meetings of the American Roentgen Ray Society, was at the Forty-eighth Annual Meeting held in Atlantic City, September 16-19, 1947, no exception. The Scientific Exhibit was arranged by the

Chairman, Dr. Robert A. Arens, and his Scientific Exhibit Committee. A detailed description of the various exhibits is given below with the awards which were given by the Society.

In the group of exhibits dealing with the chest was a very extensive one entitled "Surgical Treatment of Thoracic Lesions"

by Drs. S. W. Harrington, H. K. Gray, and O. T. Clagett (all by invitation), Mayo Clinic, Rochester, Minnesota. The exhibit consisted of wax models of the site of the tumor in relation to adjacent organs and also of the tumor following removal, together with roentgenograms, kodachrome illustrations of the pathological specimens and color photomicrographs. The exhibit dealt with (a) diagnosis and surgical treatment of lesions of the esophagus such as benign and malignant tumors and esophageal and pharyngoesophageal diverticula; (b) extrapulmonary lesions such as neurofibromas, teratomas and thymoma; (c) intrapulmonary lesions such as carcinomas of the lung and bronchus, bronchial adenomas, hamartomas, and pulmonary suppurative diseases; (d) cardiac lesions such as chronic constrictive pericarditis and patent ductus arteriosus. This exhibit alone was worth the trip to Atlantic City and its value was tremendously enhanced by the presence of Dr. Harrington, who graciously explained the exhibit in detail. This exhibit was given First Award, but this is only a slight appreciation of the Society's gratitude to Dr. Harrington and his associates for such a superb exhibit.

Another excellent and extensive exhibit was that by the United States Public Health Service, Tuberculosis Control Division (by invitation), Bethesda, Maryland, entitled "Chest Roentgen Findings Associated with Histoplasmin Sensitivity." There were many roentgenograms demonstrating chest findings associated with histoplasmin sensitivity compared with those associated with tuberculin sensitivity. These were reproductions from 14 by 17 inch originals on 8 by 10 inch film. The process of reproduction was shown by demonstrating some original 14 by 17's, intermediate mm., and facsimiles on 8 by 10 inch films.

Another exhibit took up the question of "Roentgenologic Problems in the Differential Diagnosis of Pulmonary Lesions" and was by Drs. B. P. Widmann, Herman Ostrum (by invitation), and Russell Miller (by invitation), Philadelphia General Hos-

pital, Philadelphia, Pennsylvania. The exhibit included (1) malignant lung tumors simulating tuberculosis, abscess, pneumonia; (2) mediastinal tumors: (a) anterior, (b) posterior; (3) pulmonary cysts: (a) congenital, (b) acquired, (c) parasitic; (4) isolated tumors in lung simulating metastatic malignancy: (a) tuberculomas, (b) plasmocytoma, (c) Hodgkin's, (d) sarcoïdosis; (5) lymphoblastomas: (a) Hodgkin's, (b) giant follicular lymphadenopathy, (c) leukosarcomas, (d) reticulum cell sarcoma, (e) lymphatic leukemia; (6) pseudomediastinal neoplasm: (a) cold abscess, (b) aneurysm (aortic), (c) megaesophagus, (d) cardiac aneurysm, (e) lymphatic leukemia; (7) miliary nodulations: (a) metastatic malignancy, (b) lymphogenic malignant spread, (c) hemosiderofibrosis in cardiac decompensation.

Another exhibit in this group was entitled "Tumors of the Bronchi: Roentgen Manifestations of Obstruction" by Drs. Leo G. Rigler, Thomas B. Merker (by invitation), and Robert Shapiro (by invitation), University of Minnesota, Minneapolis, Minnesota. Bronchial obstruction is one of the most important evidences of the presence of a bronchogenic carcinoma. The determination of the roentgenologic diagnosis is most commonly dependent upon the observation of the phenomena of bronchial obstruction. Diagrams, charts and films were exhibited to delineate the following stages of bronchial obstruction as described by Westermarck: (1) decreased aeration; (2) obstructive emphysema during expiration only; (3) obstructive emphysema during inspiration and expiration; (4) obstructive atelectasis, segmental, lobar or whole lung. The value of roentgenograms made in expiration was demonstrated, as well as the use of bronchography to show the character of the bronchial obstruction. Particular attention was given to the usefulness of body section roentgenography for the demonstration of tumors of the bronchi. This exhibit was awarded a Certificate of Merit.

An exhibit entitled "The Breast: Roentgenography" was presented by Drs. J.



Gershon-Cohen, Philip J. Hodes, and Harry A. Reinhart (by invitation), Philadelphia, Pennsylvania. In cancer of the breast, the methods and techniques for examining the breast roentgenographically were demonstrated. A wide range of roentgenograms of the normal breast was shown and compared with the various groups of abnormal conditions of the breast necessary to be acquainted with for differential diagnosis of breast cancer. The corresponding photomicrographs of biopsy and tissue material were part of the exhibit.

"Pulmonary Changes in Certain Conditions Due to Vascular Disease" was the title of an exhibit by Drs. Robert P. Barden and David Cooper (by invitation), Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania. New concepts of pulmonary physiology and recent advances in thoracic surgery have made necessary a critical review of pathology as revealed in roentgenograms of the chest. This exhibit illustrated the changes occurring in diseases of the peripheral vessels of the lung concerning which little information is available in the roentgenologic literature. As the cornea of the eye is considered a window through which the vascular system may be studied, so the chest roentgenograms may reflect changes occurring throughout the blood vessels of the body and be useful in the interpretation of widespread pathology in other organs. Furthermore it may be possible to determine whether disease in the chest is affecting primarily pulmonary lymphatic or vascular structures by the nature and distribution of the roentgen shadows. When it can be made this preliminary analysis is useful in differential diagnosis. From the standpoint of pathology, there are two main types of diseases affecting the peripheral vascular system of the lungs, namely those accompanied by obstruction of the lumina of vessels and reduction in the vascular bed and those which may be accompanied by increased permeability of the blood vessel walls. The exact clinical diagnosis of a disease affecting the peripheral vascular system of the lungs cannot be made from

the roentgenogram of the chest alone. However, some of these diseases are associated with distinctive shadow patterns and if this concept is utilized, the roentgen findings may be the first step in initiating conclusive diagnostic studies. Case histories accompanied by reduced films and photomicrographs were used to illustrate many of the diseases which affect the peripheral pulmonary vessels. This exhibit was awarded a Certificate of Merit.

Another very interesting and instructive exhibit was that presented by Dr. S. A. Wilson, Salem Hospital, Salem, Massachusetts, entitled "Delayed Chronic Pneumonitis Probably Due to Beryllium." This pneumonitis occurred in several industries where beryllium is used. The pneumonitis occurs both in the acute and chronic forms. The widespread possibilities of exposure in all parts of the country and the importance of the roentgen examination in the diagnosis renders it almost imperative that every roentgenologist be aware of the condition and recognize it. With an occupational history, the roentgen appearance of the chest makes the diagnosis possible. The acute forms of pneumonitis due to beryllium poisoning have already been shown to this Society in previous years by Van Ordstrand *et al.* The chronic type which was one of the features of this exhibit is less well known and therefore seems important to bring to the attention of the medical profession. Many of the cases discovered in the fluorescent tube industry have shown a delayed onset of several months to years following known exposure. Clinically the outstanding symptoms are (1) delayed onset (in many cases); (2) loss of weight; (3) cough; (4) dyspnea; (5) weakness. All cases show a reduced vital capacity; some a reversal of their AG ratio. Roentgenographically the appearance of the lung fields varies somewhat but the fine granular "sand storm" appearance is thought to be characteristic. The exhibit consisted of roentgenograms of the chest showing the disease process in its acute and chronic forms, together with kodachrome photomicrographs of some pathologic speci-

mens showing the disease. This exhibit was awarded a Certificate of Merit.

An exhibit entitled "Congenital Anomalies of the Heart and Great Vessels; Clinicopathologic Study of 115 Cases" was presented by Drs. T. J. Dry, J. E. Edwards, R. L. Parker, H. B. Burchell, A. H. Bulbulian, and H. M. Rogers (all by invitation), Mayo Clinic, Rochester, Minnesota. Representative examples of major anomalies of the heart and great vessels were demonstrated by models showing external anatomy as well as internal structure of the various types encountered; drawings explaining the abnormal circulation; roentgenograms and electrocardiograms of the various types; pertinent clinical features observed in each type, and significant embryologic considerations contributing to these congenital anomalies.

"Roentgenographic Detection of Coronary Arteriosclerosis" was the title of an exhibit by Drs. J. E. Habbe and H. H. Wright (by invitation), Milwaukee, Wisconsin. The importance of carefully centered multiple spot roentgenograms and of kymography in left oblique and postero-anterior positions as a means of detection of coronary calcification was emphasized. The technique can be readily utilized as an integral part of every complete roentgenologic examination of the heart and should reveal earlier degrees of coronary arteriosclerosis which may not yet be discernible roentgenoscopically. The exhibit consisted of multiple spot roentgenograms as well as kymograms demonstrating arteriosclerosis of the coronary vessels and particularly useful in the exhibit was a demonstration of the various positions of the patients for the proper study of the coronary vessel area.

The final exhibit in the section on the chest was one by Drs. John W. Pierson and John J. Douglas (by invitation), Baltimore, Maryland, entitled "The Roentgenological Diagnosis of Congenital Heart Disease." This exhibit consisted of roentgenograms, anatomical drawings and charts mounted on roentgen films, to depict the embryological, anatomical, and roentgenographic changes occurring in the various types of

congenital heart lesions. A paper on the same subject was given in the scientific program.

In the two exhibits dealing with the abdomen was one by Drs. William A. Evans and Wolfgang Zuelzer (by invitation), Children's Hospital of Michigan, Detroit, Michigan, entitled "Fibrocystic Disease of the Pancreas; Roentgenological and Pathological Manifestations." The exhibit consisted of roentgenograms and kodachrome slides of pathological specimens obtained from 15 cases of fibrocystic disease of the pancreas. The cases were grouped according to the classification of Anderson and Farber. In Group I were 4 cases of meconium ileus in which death occurred in the neonatal period due to intestinal obstruction by inspissated meconium. In Group II were 6 cases dying in early infancy with manifestations of respiratory obstruction and infection. Group III consisted of 5 cases dying at a somewhat later period with some of the features of "celiac disease" in addition to symptoms of chronic respiratory infection and obstruction. The pathologic specimens illustrated the character of the inspissated meconium and the gross appearance of the distended bowel in meconium ileus. The character of the thick tracheobronchial secretions and the gross as well as microscopic appearance of the lungs were also illustrated by colored slides.

"An Additional Aid for Use in Diagnosis of Gastric Lesions" was the title of an exhibit by Drs. Everett L. Pirkey (by invitation), and Sydney E. Johnson (by invitation), University of Louisville School of Medicine, Louisville, Kentucky. The exhibit consisted of roentgenograms illustrating the use of this additional method. It has been found to be of particular value in the localization and differentiation of pathology about the fundus of the stomach. It is a means of indirect palpation of the portions of the stomach ordinarily not easily examined. The authors present method consists of the customary roentgenoscopic examination of the barium-filled stomach with the usual films exposed.

The patient then swallows the stomach tube (Rehfuss or Levine) with a latex condom tied tightly proximal to all the holes in the tube. The end bulb from a blood pressure apparatus is attached to the outside end of the tube and under roentgenoscopic control a balloon is inflated to any desired degree. The maximum pressure that has been used has never exceeded 20 mm. of mercury as measured by the large dial sphygmomanometer. Positioning the patient with the balloon thus inflated all the portions of the stomach may be examined.

An exhibit in the group having to do with the skeletal system was arranged by Drs. Lester W. Paul and William W. Moir (by invitation), University of Wisconsin Medical School, Madison, Wisconsin and was entitled "Non-pathologic Variations in Relationships of the Upper Cervical Vertebrae." In anteroposterior roentgenograms of the cervical spine an apparent abnormality in alignment of the first and second cervical vertebrae occasionally is encountered. If the examination is done because of an injury to the neck the question arises as to the presence of a partial subluxation of these vertebrae. A study of a large number of normals was made to determine if this variation in alignment was to be found without a history of antecedent injury or disease and its frequency of occurrence. It was shown that such an asymmetry is relatively common and that the relationships of these two vertebrae may vary within rather wide limits as seen in anteroposterior roentgenograms. The effect of lateral flexion and of forceful bending in producing or correcting this asymmetry was illustrated. A paper on the same subject was presented in the scientific program.

Dr. Raymond W. Lewis (by invitation), Hospital for Special Surgery, New York, New York, presented an exhibit on the subject "Roentgen-Ray Diagnosis of Pigmented Villonodular Synovitis and Synovial Sarcoma of the Knee Joint." The exhibit consisted of transparencies showing the pathology of villonodular synovitis; roentgenograms of proved cases of vil-

lonodular synovitis; roentgenogram of synovial sarcoma indistinguishable from villonodular synovitis; three cases of synovial sarcoma which could be differentiated from villonodular synovitis; transparencies giving explanatory and descriptive text. This exhibit was awarded a Certificate of Merit.

Another exhibit in the group having to do with the skeletal system was presented by Drs. E. S. Gurdjian, J. E. Webster, and H. R. Lissner (all by invitation), Wayne University College of Medicine and Grace Hospital, Detroit, Michigan, entitled "Mechanism of Production of Linear Skull Fracture: Studies with the Stresscoat." The material consisted of experimental work in dogs, monkeys, and human studies on cadaver and dry skulls with the Stresscoat technique. A strain sensitive lacquer is applied on the external and internal surfaces of the skull; deformation of the skull from blows causes cracks in the lacquer showing the pattern and direction of the strains. It has been shown that the skull of the dog and the monkey under nembutal anesthesia has strain patterns similar to the dry skull in the same animal. The strain patterns of human cadaver skulls and dry skulls are also similar. When both the external and internal surfaces are available for study, bending activity of the skull can be visualized. Following impact, there is an area of inbended bone. Peripheral to this region, there is selective outbending of the skull as shown by the Stresscoat technique. Linear fractures are initiated at a distance from the point of impact and result from outbending of the bone. The fracture line propagates toward the point of impact and in the opposite direction. This exhibit was given the Third Award.

An exhibit from the University of Michigan, Ann Arbor, Michigan, by Drs. John F. Holt (by invitation), and Edwin M. Wright (by invitation), was on "Neurofibromatosis of Bone." The relatively high incidence of skeletal abnormalities associated with neurofibromatosis of the skin and subcutaneous tissues deserves the attention of every radiologist. These osseous changes

are so common and so variable in form and location that they may be erroneously interpreted as independent disease entities rather than local manifestations of a more or less generalized disorder. Roentgenologic material obtained from a review of approximately 150 cases of neurofibromatosis was employed in an attempt to correlate, classify, and graphically illustrate the various skeletal aberrations which may be encountered. The differential diagnosis was also considered. The reproductions of the roentgenograms were in browntone. This exhibit was given a Certificate of Merit.

Drs. J. A. Campbell and W. C. Mullen, Indiana University Department of Radiology, Indianapolis, Indiana, presented an exhibit entitled "Congenital Anomalies in Pediatrics. Part I. Congenital Anomalies of the Head." This exhibit was prepared for teaching of Indiana University residents and medical students in radiology and pediatrics. It did not represent a demonstration of all possible congenital abnormalities, but included many of the more common entities which emphasize the variety of conditions encountered and identified by simple roentgenographic methods. The lesions illustrated in this exhibit are familiar to all experienced roentgenologists, but it was thought that a review of this subject grouped by systems would be of some general interest.

In the group of exhibits having to do with therapy was an interesting one by Dr. Maurice Lenz, New York, New York, on "Radiocurability of Cancer." Curability of cancer by radiotherapy (roentgen ray, radium, radioactive substances) depends on the natural growth characteristics, extent, location, microscopic structure and inherent radiosensitivity of the cancer and on the radioresistance of the irradiated normal tissues, tolerance of the patient, dosage of radiation reaching the tumor and technique of radiotherapy. The relationship of these various factors to the five year freedom from clinical evidence of cancer was illustrated on transparencies. This exhibit was given a Certificate of Merit.

The subject of "Intractable Neoplasms:

Eradication by Irradiation with Surgical Repair" was presented by Drs. Donald H. Breit (by invitation), Sioux Falls, South Dakota, and Howard B. Hunt, Omaha, Nebraska. Roentgen rays, radium and surgery are combined in the treatment of cutaneous and subcutaneous neoplasms; primary treatment by irradiation for more certain eradication. Avascular necrosis and defects are repaired surgically when necessary to facilitate hearing or to obtain more durable skin and subcutaneous tissue. The exhibit consisted of many kodachromes of various stages of cancer before and following treatment.

"Introduction of Composite Face Cast in the Treatment of Epidermal and Oral Carcinoma" was the title of an exhibit by Dr. S. Gordon Castigliano (by invitation) and J. L. Weatherwax, M.A., American Oncologic Hospital, Philadelphia, Pennsylvania. The exhibit demonstrated through the use of large photographs in framed mounts precise radiation therapy, using lead face masks which are swaged from a master or composite face cast. In addition, the exhibitors demonstrated the use of the composite cast for the swaging of lead masks in different areas of the face. A number of typical cases, some in color, were presented showing the lesions in various stages both before and after treatment.

Another exhibit in the section on therapy was prepared by Dr. Erich M. Uhlmann (by invitation), Michael Reese Hospital, Chicago, Illinois, on "Treatment of Radiation Injuries." This was a display of photographs and kodachrome transparencies of patients treated with radon in ointment. These were taken before and after treatment.

"Roentgen Rays in Prevention and Treatment of Infections" was the subject of an exhibit by Drs. James F. Kelly, D. A. Dowell, J. E. Downing (by invitation), and J. F. Kelly, Jr. (by invitation), Creighton University Medical School, Omaha, Nebraska. This contained experimental and clinical data which support the contention of certain radiologists since the roentgen rays were discovered fifty years ago that

the rays are valuable in the management of infection. It would seem from the data presented that no patient should be allowed to die from bacterial toxemia due to an acute infection without benefit of roentgen therapy. If the sulfonamides are used simultaneously, no benefit will be obtained.

"Expanding Cervical Vaginal Radium Colpostat: Clinical Use in Cancer of the Cervix" was demonstrated by Dr. Edwin C. Ernst, Barnard Free Skin and Cancer Hospital, St. Louis, Missouri. An improved mechanical feature of the new expanding cervical-vaginal radium colpostat applicator was presented together with a description of the clinical uses and methods of application of this radium holder for more effective treatment of cancer of the cervix. Preliminary clinical observations of fifty cases of cervical cancer were included. This exhibit was given a Certificate of Merit.

An exhibit by Dr. Robert B. Taft, Charleston, South Carolina, was entitled "Radiation Meter." An x-ray constancy meter with a small thimble chamber was shown. This is intended to be permanently mounted in a therapy machine and in no way interferes with the removal of any or all cones. The circuit is an extremely simplified one which has given good service over a period of a number of years and has never been shown before.

"Chemotherapy Masking Symptomatology: Increasing Responsibility of the Radiologist" was the subject of an exhibit by Drs. V. W. Archer, George Cooper, Jr., and Norman Adair (by invitation), University of Virginia Hospital, Charlottesville, Virginia. Symptomatology was markedly altered by chemotherapy in the following conditions: diverticulitis with malignancy; fibrosarcoma; perinephritic abscess; lung abscess; acute cholecystitis; mastoiditis; subphrenic and subhepatic abscess; empyema; osteomyelitis. The radiologist must accept an increasingly large share of the responsibility for correct evaluation of progression or regression of pathological processes due to infection when treated by chemotherapy. This ex-

hibit illustrated in a very clear cut fashion the importance of clinical knowledge in the interpretation of disease processes.

A very timely exhibit was presented by Edith H. Quimby, Sc.D., Columbia University, New York, New York, entitled "Radioactive Isotopes in Biology and Medicine." This exhibit consisted of fourteen charts each 22 by 28 inches with the following titles: radioactive isotopes; nuclear chemistry (equations for production of isotopes); unit for radioactive isotopes; measurement of radioactive isotopes; dose of radiation delivered by radioactive isotopes; safety and protection; two general uses of isotopes (tracer and therapy); radioautographs (with several pictures); radioactive sodium as a tracer (with clinical records); radioactive sodium in therapy (with a case history); radioactive iodine as a tracer (with data for measurement of thyroid function in children); radioactive iodine in therapy; radioactive phosphorus in therapy; other radioactive isotopes. This exhibit received the Second Award.

"X-ray Diffraction of Normal and Pathological Tissues" was the subject of an exhibit by S. Feitelberg (by invitation) and P. E. Kaunitz (by invitation), Departments of Pathology and Physics, Division of Laboratories, Mount Sinai Hospital, New York, New York. The exhibit presented x-ray diffraction patterns and photomicrographs of normal and pathologic human tissues. The characteristics of the x-ray diffraction pattern make it possible to estimate relative degrees of molecular orientation. The first series of pictures showed the increase of molecular orientation of collagen with increased age. The method of examination also makes it possible to determine the identity of materials where histologic examination is inconclusive. The second series were photomicrographs and diffraction patterns of rheumatic nodules of the heart and skin. The greater portion of these nodules appears histologically as connective tissue, and the diffraction pattern typical of collagen confirms this finding. In each nodule there is an area appearing as "fibrinoid

degeneration" histologically, and considered to indicate collagen that has undergone degeneration so that it is histologically indistinguishable from fibrin. However, diffraction examination of degenerated area reveals the typical pattern of fibrin. The x-ray diffraction pictures were obtained with the use of a microcamera, which permits collimation of the roentgen-ray beam to a diameter of 50 micra, with light-microscope control for the selection of the desired area.

### TECHNICAL EXHIBIT

The Forty-eighth Annual Meeting of the American Roentgen Ray Society held at Haddon Hall, Atlantic City, September 16-19, 1947, was an occasion for the technical exhibitors to present the newer types of equipment which they have engineered and manufactured within the last years. The Technical Exhibit was outstanding in all details. This fact may be attested to in that twenty-nine manufacturers had reserved a total of sixty-one booths and 236 technical exhibitors were registered at the meeting. Haddon Hall lends itself admirably to the display of a technical exhibit and the exhibits were beautifully disposed and were accessible to all who were interested. The technical exhibitors not only had displayed their wares in an excellent manner but they gave freely of their time to the interested members of the Society and guests in explaining the various types of apparatus. The publishers of scientific books were well represented, thus adding to the intellectual requirements of the radiologists. Their books were displayed in an attractive manner and covered a wide range of medicine dealing with radiological problems. The Society is always appreciative of the continued interest shown by the manufacturers and the publishing houses in the annual meetings.

The following firms were represented in the Technical Exhibit: *AnSCO*, Binghamton, N. Y.; *George W. Borg Corporation*, Delavan, Wis.; *Buck X-Ograph Company*, St. Louis, Mo.; *Canadian Radium and Uranium Corporation*, New York, N. Y.;

*F. A. Davis Company*, Philadelphia, Pa.; *E. I. duPont de Nemours and Company*, Wilmington, Del.; *Eastman Kodak Company*, Rochester, N. Y.; *Eureka X-Ray Tube Corporation*, Chicago, Ill.; *General Electric X-Ray Corporation*, Chicago, Ill.; *High Voltage Engineering Corporation*, Cambridge, Mass.; *Paul B. Hoeber*, New York, N. Y.; *Kelley-Koett Manufacturing Company*, Covington, Ky.; *Lea and Febiger*, Philadelphia, Pa.; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Conn.; *F. Mattern Manufacturing Company*, Chicago, Ill.; *National Synthetics*, New York, N. Y.; *North American Philips Company*, New York, N. Y.; *Picker X-Ray Corporation*, New York, N. Y.; *Schering Corporation*, Bloomfield, N. J.; *Frank Scholz*, Boston, Mass.; *Standard X-Ray Company*, Chicago, Ill.; *Charles C Thomas*, Springfield, Ill.; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse Electric Corporation*, Pittsburgh, Pa.; *Winthrop Chemical Company*, New York, N. Y.; *Wolf X-Ray Products*, New York, N. Y.; *Wright Engineering Company*, Mountain Lakes, N. J.; *Year Book Publishers*, Chicago, Ill.

### NEW OFFICERS

At the Forty-eighth Annual Meeting of the American Roentgen Ray Society held at Haddon Hall, Atlantic City, New Jersey, September 16-19, 1947, the following officers were elected for the year 1947-1948: *President-Elect*: Lawrence Reynolds, Detroit, Mich.; *1st Vice-President*: Joshua C. Dickinson, Tampa, Florida; *2nd Vice-President*: Robert A. Bradley, Atlantic City, N. J.; *Secretary*: H. Dabney Kerr, Iowa City, Iowa (re-elected); *Treasurer*: Wendell G. Scott, St. Louis, Mo. (re-elected); *Members of the Executive Council*: Hugh F. Hare, Boston, Mass. (for two years); Milton J. Geyman, Santa Barbara, Calif. (for three years); *Historian*: Ramsay Spillman, New York, N. Y. The *President* is J. Bennett Edwards, Leonia, N. J., and the *Chairman of the Executive Council* is Vincent W. Archer, University, Virginia.

## DEPARTMENT OF TECHNIQUE

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## THE OBLIQUE PROJECTION IN UROGRAPHY\*

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ALTHOUGH the literature of urologic roentgen diagnosis stresses the value of stereoscopy and occasionally the true lateral study in the localization of calculi, neoplasms, foreign bodies, extra-ureteral and renal masses, and in ectopia, only very casual mention is made of the oblique projection in such studies,<sup>1,2,3</sup> it has been our experience that the oblique projection of the visualized urinary tract often furnishes information not available in the anteroposterior, stereoscopic, or lateral views, and this diagnostic maneuver has been used constantly in the University of Michigan

Urology Clinic since 1928. On August 21, 1928, Dr. Preston M. Hickey first used the oblique projection to demonstrate the position of a calculus in the lower right ureter after the routine studies failed to make the diagnosis of a calculus positive.

The principle of parallax, that is the apparent change of spatial relations of structures due to change of projection, is the same in stereoscopy and in the oblique projection, with, however, greater exaggeration in the latter, thus affording easier diagnosis. This principle is well shown in Figures 3 and 4 where the separation of



FIG. 1 and 2. Cork wedge used in obtaining oblique position.

\* From the Department of Surgery, University of Michigan Medical School, Ann Arbor, Michigan.



FIG. 3

FIG. 3. Anteroposterior projection suggests possibility of a left lower ureteral calculus.



FIG. 4

FIG. 4. Left oblique projection gives parallax revealing extra-ureteral location of density.

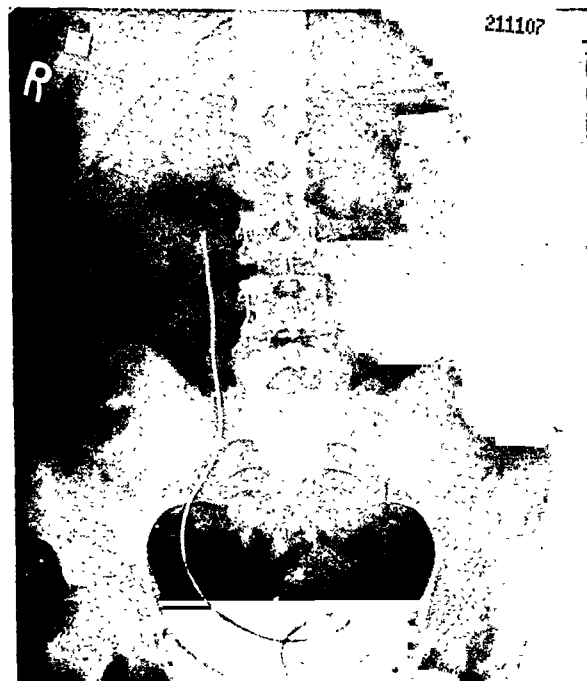


FIG. 5

FIG. 5. Anteroposterior view reveals calcific density overlying lower right ureter.



FIG. 6

FIG. 6. Oblique projection confirms diagnosis of lower right ureteral calculus.





FIG. 7



FIG. 8

FIG. 7. Anteroposterior view suggests calcified neoplasm of right kidney.  
FIG. 8. Oblique projection reveals extrarenal location of density.



FIG. 9



FIG. 10

FIG. 9. Right ureteral catheter buckled in ureter suggesting obstruction.  
FIG. 10. Anteroposterior view shows no disease.

catheter and calcific density in the oblique study eliminates the diagnosis of ureteral calculus.

Besides the principle of parallax, the oblique projection also affords clearer delineation of the distal two-thirds of the ureter. With projection of the ureter laterally over the less dense portion of the ilium, opaque medium in the ureter will often reveal disease not seen in the conventional views because the ureter is projected over the dense sacroiliac area. This advantage is well illustrated in Figures 9, 10 and 11. The ureteral neoplasm is beautifully outlined in the right oblique projection and completely concealed in the routine anteroposterior view. In the upper tract, the oblique projection also has merit. True lateral projections preclude the use of excretory pyelograms because of superimposition of the renal shadows. Generally, renal or extra-renal shadows or distortions as shown in Figures 7 and 8 will be interpreted correctly when an oblique study is made.

The oblique projection may be obtained by altering either the position of the patient or the direction of the roentgen-ray beam, but the former procedure is generally simpler. This can be done by placing a cork wedge 12 by 12 by 6 inches with an angle of 40 degrees under the normal flank giving an oblique view of the presumably diseased side (Fig. 1 and 2). The cork wedge can be easily constructed by gluing several layers of cork together and cutting to proper size and angle.

The oblique projection is used routinely in all cases of suspected calculi or urethral neoplasm, saving repetition of urograms in those cases in which the diagnosis may not be apparent from the conventional projections.

#### CONCLUSION

The oblique projection in urography is a valuable diagnostic aid that offers im-

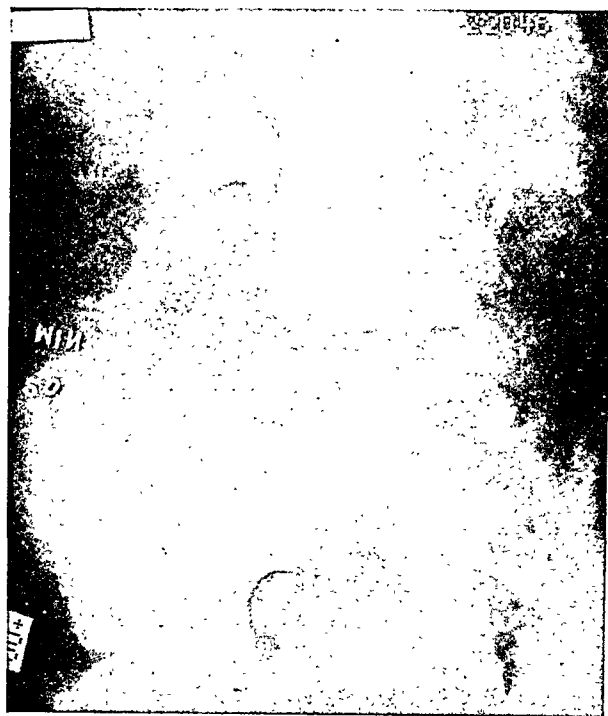


FIG. 11. Right oblique projection reveals neoplasm of ureter. (Pathological report: Primary medullary carcinoma of ureter.)

proved visualization of the ureter by projecting it over a less dense bony area and by utilizing fully the principle of parallax. Belated credit is given to Dr. Preston M. Hickey for his important contribution.

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Ann Arbor, Mich.

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# MANUAL MANIPULATION AS A DIAGNOSTIC AID IN THE ROENTGENOLOGICAL DIFFERENTIATION OF INTRA-ABDOMINAL CALCIFICATIONS, ESPECIALLY RENAL CALCULI

By MAJOR S. SAMETNIK\*

ROYAL ARMY MEDICAL CORPS

THERE are many intrarenal and extra-renal conditions which may produce radiopacities projecting into or near the kidney area, for example: (1) Calculi in the kidney or in the renal pelvis. (2) Calcified mesenteric glands. Unless these are multiple and of characteristic texture, a series of roentgenograms may be required for diagnosis by demonstrating their changes of site. Lateral views may show them to be in the anterior portion of the abdominal cavity. In some cases, only stereoscopic views taken with a ureteric catheter in position will enable a decision to be made.

(3) Calcified, especially solitary, gallstones. Here again, a number of investigations, including posteroanterior and lateral views, cholecystography, perhaps combined with urography, may be required. (4) Pathological calcifications in the liver and in the spleen. (5) Radiopaque intestinal contents (enteroliths) or barium impregnated scybala. These may also cause confusion and require special preparation and a series of roentgenograms.



FIG. 1. Normal intravenous pyelogram.



FIG. 2. Same case as Figure 1 showing manual displacement of kidney, pelvis and ureter.

\* Radiologist to a General Hospital, M. E. F.



FIG. 3. Straight film showing two opacities in the kidney area.

To prove that the calcification is within the kidney, the following examinations are usually carried out:

(1) Roentgenograms, taken in different planes, place the shadow within the renal outline. Difficulties occur if the kidney outline is obscured by gas or by colonic contents. Calculi which are small or of low density may not be visible through the lumbar spine in the lateral view. Only the larger stones, particularly those in the renal pelvis, are easily diagnosed by means of their shape and texture.

(2) Roentgenograms taken in inspiration and expiration showing respiratory shift of the radiopacity together with the kidney, which has to be outlined clearly. This is considered to be a valuable sign by some workers but quite unreliable by others.

(3) The next step is usually retrograde or intravenous urography (perhaps combined). The larger shadows may be local-

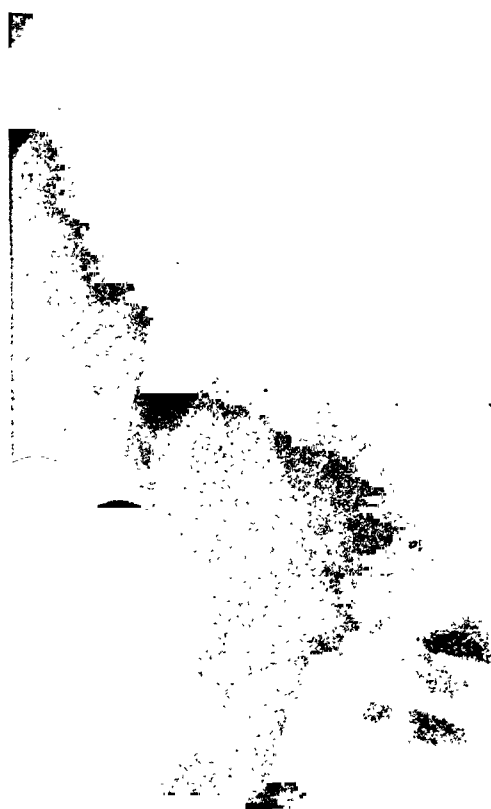


FIG. 4. Same case as Figure 3, showing displacement of the opacities by pressure as described in the text.

ized as a "filling defect" by these means, but small or faint shadows may be obscured by dye and remain unconfirmed. Often many roentgenograms are required to prove the opacity to be renal in origin.

In a large number of examinations I have found the following manipulation to be a very satisfactory diagnostic aid in the localization of these opacities. There is nothing new under the sun and I use the method long known to clinicians of rendering the kidney more palpable by pressure from behind.

The technique of the manipulation is a very simple one. It is essential to have a perfect dark adaptation and I always do these cases at the end of a series of examinations. With the patient in the upright position and the diaphragm narrowed down to the area under view, the glove-protected hand touches the patient's back with one or more fingers and presses gently in the



FIG. 5. This case showed on the straight film (not reproduced here) shadows in the renal area and in the line of the ureter. This figure shows the lower opacities displaced laterally by the front pressure indicating that they are produced by calcified mesenteric glands.

costolumbar angle. The touching finger must of course avoid obscuring the opacity. Sometimes the pressure should be made from a more lateral position, in the direction of the spine. The patient breathes normally and the respiratory shift of the opacity may be studied at the same time. Usually a clearer view is seen during inspiration. Very firm pressure is required only if the lumbar muscles are rigid or irritable owing to pain. The outline of the kidney is of course not seen, but any shadow in the kidney or very close to it, as in the pelvis, upper ureter, and so forth, is immediately seen to move as the finger pushes and displaces the kidney, but shadows or more remote structures are not affected. The usual direction of displacement is forward, slightly upward and inward (Fig. 1 and 2).

The movement of the larger shadows is very obvious and roentgenographic control is seldom required. However, when the opacities are too small to be recognized during the screening a roentgenogram must be taken.

The patient lies in the supine position on the Potter-Bucky table and with the palpating finger pressing inward from the lateral lumbar region to avoid obscuring the opacity, an exposure is made preferably in inspiration. Comparison is then made with the previous routine roentgenogram taken under the same conditions and the displacement of the opacity is clearly seen even if the outlines of the kidney are obscure. The criterion of displacement is the altered relation between the opacity and the transverse processes of the lumbar spine (Fig. 3 and 4).

This manual manipulation may also provide additional useful information.

(1) Differentiation of superimposed shadows into their components by the displacement and rotation of the kidney.



FIG. 6. Straight film shows large opacity—easily recognizable during roentgenoscopy.

Similarly opacities which appear to be within the kidney outline are shown to be really outside the kidney altogether or within the pelvis or upper ureter.

(2) A normal or pathological kidney is often rendered more easily visible.

(3) In retrograde or intravenous urograms the condition of ill defined structures

tion are avoided. Furthermore, the coexistence of gallstones and kidney stones may be demonstrated by these tests. As illustrative examples I have chosen only a few cases showing the usual type of comparatively small opacity, since it may be imagined that the demonstration of the larger shadows is a very easy matter (Fig. 6 and 7).



FIG. 7. Same case as Figure 6 showing effects of the displacement of the opacity (mesenteric gland) by slight pressure on the anterior abdominal wall.

may be studied and opacities wholly or partly obscured by dye may be recognized.

(4) Pathological fixation of kidney may be demonstrated.

As a variation of the above I frequently use a front pressure for differentiation of doubtful opacities such as gallstones, pathological splenic calcifications, intestinal radiopaque contents, calcified glands which do not always show typical stippling and which project upon the kidney area or the line of ureter. These are usually simply recognized during roentgenoscopy by a similar maneuver applied this time to the anterior abdominal wall with the patient standing facing the examiner or in the supine position. In doubtful cases a film may be exposed (Fig. 5). Once again complicated examinations and the expenditure of serial films to show the changes of posi-

#### SUMMARY

A simple manipulation is described which it is hoped will be considered to be of value in the roentgenological localization of intra-abdominal calcifications. This should be used only in conjunction with clinical and other examinations and is of special value in the diagnosis of renal calculi. I have found that this manipulation often obviates the necessity of procedures which are unpleasant for the patient, complicated and expensive.

I wish to thank Colonel A. A. M. Davies, Commanding Officer of this General Hospital, for his permission to publish these notes and Lieutenant Colonel R. M. Patterson, Adviser in Radiology, M. E. F. for his interest.

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## ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

### ROENTGEN DIAGNOSIS

#### GENITOURINARY SYSTEM

FLOCKS, R. H. "Early" calcium urolithiasis. *J.A.M.A.*, April 6, 1946, 130, 913-918.

The author presents a study of the factors leading to urolithiasis in conditions in which immobilization of the individual is present, in which portions of the urinary tract are paralyzed, and in which there is obstruction or infection of the urinary tract.

Urinary stasis, infection and hypercalcemia are the three main factors in the production of urolithiasis. In the vast majority of cases there are multiple small precipitates of calcium phosphate deposited in the renal pelves and calyces, these forming within periods as short as eighteen days after the initiation of the predisposing factors.

Precipitation of the crystalloids and the formation of calculi take place gradually, but with varying degrees of rapidity and without symptoms, so that in many of these cases the diagnosis is first made by means of roentgen examination. After a varying interval, symptoms occur in one or more of the following ways: (1) hematuria; (2) ureteral colic; (3) infection. The importance of recognizing this type of urolithiasis in the "early" stage (non-hardened stage)

during the months in which it is amenable to irrigation therapy is stressed by the author.

The pathologic changes in the cases of simple precipitation are slight; the kidney and pelvis are normal except for evidences of slight irritation of the mucosa by the precipitated urates. With the onset of infection there is much more rapid growth of stones by further precipitation; there may be precipitations of calcium phosphate in the tubules, ulcerations of the tips of the pyramids and sometimes the deposition of stones in the ulcerations. In the discovery of infection adequate drainage must be instituted immediately and steps taken to control the infection.

In late chronic cases the pelves and calyces are distorted by scar tissue and infiltration.

The changes demonstrable by roentgen examination are characteristic. In the early stages there is a typical irregular opacity suggesting the presence of calcium salts in the calyces or renal parenchyma. If severe infection is present there is consolidation of the particles into stones. There is usually dilatation of the kidney pelvis and other evidences of obstruction. In late cases the stone shadows are characteristically more dense. The author stresses the importance of early recognition of the condition so that cure may be obtained by high fluid and acid ash diet. Later, operative procedures and drainage are necessary.—*Charles B. Cobern.*



LEVANT, BENJAMIN, and LEE, JAMES J. Intramuscular urography. *Pennsylvania M. J.*, Dec., 1945, 49, 255-257.

Investigation of the urinary tract in children is now accepted as a well established and necessary procedure. Such studies may be obtained either by cystoscopy and retrograde pyelography or by excretory urography. The authors summarize their experience with 42 cases in which the intramuscular method of excretory urography was used. The patients ranged in age from one month to fifteen years. This method, recommended by Hunt and Popma in 1939, has proved so simple and so easily accomplished that the authors have given up intravenous urography in children. By their method, after routine preparation and after the patient has been tested for sensitivity to the iodine preparation to be used, the child is placed face down on a table and 10 to 20 cc. of 35 per cent solution of diodrast is given intramuscularly into the buttocks, half at each side. The exact dose is determined by the size and age of the patient. The entire procedure takes less than sixty seconds. A plain film is made before injection and exposures made 10, 20 and 30 minutes after injection. They believe the visualization of the urinary tract by this method is superior to other excretory methods and no untoward effects were reported.

When the urinary symptoms are referable to the bladder or urethra, excretory urography should be supplemented by cystoscopy.—*Charles B. Cobern.*

#### NERVOUS SYSTEM

HYNDMAN, OLAN R., and GERBER, WILLIAM F. Spinal extradural cysts, congenital and acquired. *J. Neurosurg.*, Nov., 1946, 3, 474-486.

The authors report the 22nd case of congenital spinal extradural cyst. In essentially all of its clinical characteristics it conforms with the other cases reported. The cyst manifested itself and was discovered in most instances before the patient was twenty years of age. The cyst is almost consistently located in the mid-thoracic region. It compresses the cord forward producing signs and symptoms of such compression: motor weakness in the lower extremities associated with spasticity, hyperactive deep reflexes and the Babinski sign; varying degrees of loss of sensibility to touch, pain and temperature discrimination; some loss of sense

of position and two point discrimination, and in some cases a loss of bowel and bladder control.

A spinal puncture below the lesion reveals a marked increase in protein in the spinal fluid and a partial or complete block when the Queckenstedt test is performed.

The roentgenogram of the dorsal spine is of special interest because it has consistently revealed a kyphosis or scoliosis. In addition to the kyphosis there is usually a widening of the spinal canal due to a smooth erosion of the pedicles over several segments. In the case presented by the authors the roentgen studies of the skull and long bones were negative but the dorsal spine showed a mild scoliosis with convexity to the right. The center of the convexity was at the fifth and sixth dorsal vertebrae. The spinal canal was widened and the pedicles were narrowed at the sixth, seventh and eighth dorsal vertebrae. At operation the spinal canal was wider than normal at these three vertebrae in keeping with the roentgen findings.

In considering a differential diagnosis there are few lesions that present the combination of symptoms and signs that have characterized the congenital extradural cyst: its manifestation during youth, the signs and symptoms of an expanding mass in the dorsal spine and roentgen findings which betray an expanding mass of long standing within the spinal canal suggesting a benign or congenital lesion. Syringomyelia and intramedullary tumors may, however, simulate many of these features.

A case of spongioblastoma is presented in relation to the differential diagnosis because the case was indistinguishable clinically from the syndrome of spinal extradural cyst.

The authors also present 2 cases of acquired extradural cyst, one developed in the low cervical region, manifesting itself about six months after removal of an extradural meningioma. The cause was a small persistent fistula in the axilla of the junction of a nerve root and spinal dura. In the other case a cyst developed after removal of an intradural perineural fibrosarcoma. The cause was a small persistent fistula in the old line of dural incision. Lipiodol was injected into the subarachnoid space and roentgenograms showed the level of the spinal block.—*K. K. Latteier.*

INGRAHAM, FRANC D., and BAILEY, ORVILLE T. Cystic teratomas and teratoid tumors of the

central nervous system in infancy and childhood. *J. Neurosurg.*, Nov., 1946, 3, 511-532.

Fifteen instances of cystic teratoma and teratoid tumor of the central nervous system in children are described by the authors. Eight of these were intracranial and seven intraspinal.

All contained one or more cysts. The tumors contained tissue elements in their solid portions varying from only keratinizing epithelium to mixtures derived from all germ layers. One tumor, made up of undifferentiated nerve and striated muscle cells, was highly malignant, freely invading the cerebellum and seeding the meninges.

Nothing was encountered that would suggest the pathological diagnosis preoperatively, unless an associated congenital anomaly was present. This occurred occasionally in the intracranial group but more often in the intraspinal group. It does not establish the diagnosis but makes the chances of finding this lesion somewhat greater than its absence. It would be unusual to find a glioma in a patient with a skull defect or superficial cranial malformation but hemangiomas or similar tumors might well be encountered.

Roentgenograms of the skull might possibly show calcified areas suggesting the presence of bone or other organoid structures in tumors of this group. In none of the patients in this series was it possible to make a definite diagnosis of the type of lesion from the roentgenograms. There was evidence of increased intracranial pressure and, in some, internal hydrocephalus was present. Ventriculograms or encephalograms demonstrated filling defects indicating the size and location of the tumors.

In the intraspinal group roentgenograms were chiefly useful for demonstration of the presence and extent of an anomaly of the vertebral column. Other roentgenographic studies for further localization and definition of the extent of the lesion were made as indicated as with any intraspinal tumor.

The diagnosis could be established at operation by finding keratinized or ciliated cells in the cyst fluids or by frozen section.

To say a patient has a teratoma or teratoid tumor of the central nervous system is no more indicative of the clinical result to be expected than to say the patient has a tumor. Some are simply removed, some are cured after a series of operations, some remain quiescent even though incompletely removed, some are so extensive

that radical surgery is impossible, and some are invasive and malignant.—K. K. Latteier.

SHENKIN, HENRY A., and PERRYMAN, CHARLES R. Reversibility of cerebral ventricular dilatation. *J. Neurosurg.*, May, 1946, 3, 234-238.

Three cases are reported of internal hydrocephalus caused by an obstructing lesion in either the third or fourth ventricle. These were studied by ventriculography and ventriculoencephalography before and after relief of the obstruction. In each case, the lateral ventricles were smaller after operation. It is the author's opinion that ventricular size is reversible in many instances, if the dilatation of the ventricles is due to an obstructive lesion, and the obstruction has not been present too long. The variation in the size of the ventricles is well illustrated in the reproductions of the roentgenograms of all 3 cases.—K. K. Latteier.

WHITCOMB, BENJAMIN B., and WYATT, GEORGE M. Technique of pantopaque myelography. *J. Neurosurg.*, Jan., 1946, 3, 95-99.

The purpose of this paper is to stress a number of details that the authors and co-workers have found to reduce their difficulties and failures in myelography. Complications consisting of bloody taps and subdural injections were encountered in approximately 10 per cent of examinations in a series of 675 myelograms. In each instance of failure a successful examination was possible at a later date.

In simplifying the procedure all but paralyzed or badly disabled patients remained ambulatory after examination. Premedication was not used and incidence of headaches was reduced. The average time required to perform a myelogram was about twenty minutes.

The authors describe in detail the spinal puncture technique, stressing the importance of knowing the position of the needle bevel in obtaining midline punctures. In the event of a bloody tap or failure to obtain a free flow of fluid, the examination is discontinued and postponed for at least ten days. The site of injection in lumbar myelography is usually the 3rd interspace. This allows clear fluoroscopic vision of the lower two lumbar interspaces, where the ruptured discs are most commonly found. In cervical myelography the injection may be at a lower level to facilitate removal of the oil.

The roentgen examination included fluoros-

copy and spot films without the use of a grid. Oblique views were taken only at suspicious levels in the lumbar region. Lateral views had been discontinued as they gave no additional information. Better visualization of the root sheaths was obtained by running the pantopaque caudally during fluoroscopy. Two views of each interspace, one with it partially covered, and another with it completely covered by pantopaque, aided in recognizing midline defects.

Removal of the pantopaque was practically complete in all instances by using the methods described by the authors. At no time was it necessary to leave more than 0.5 cc. in the subarachnoid space. In the case of subdural injection 50 to 90 per cent has usually been removed.—K. K. Latteier.

PUCKETT, WILLIAM O., GRUNDFEST, HARRY, McELROY, WILLIAM D., and McMILLEN, J. H. Damage to peripheral nerves by high velocity missiles without a direct hit. *J. Neurosurg.*, July, 1946, 3, 294-305.

The sciatic nerves of living, anesthetized cats were made radiopaque by the injection of either iodobenzene or iodophenylundecylate. High velocity missiles were fired into the thighs of such cats and the deviation of the nerve was recorded by microsecond roentgenograms. These were made with the roentgen-ray beam directed parallel to the path of the missile, while the missile passed through the soft tissues of the thigh without striking the nerve. These roentgenograms show that the nerve is rapidly blown aside during the expansion of the large temporary cavity which is formed by the missile.

Conduction studies show that functional and anatomical damage can be produced in nerves which have been subject to such displacement without leaving gross signs of damage to the nerve. Histologic studies show that the loss of function can be attributed to a series of minor breaks within the nerve sheath.—K. K. Latteier.

CHILDE, ARTHUR E. The role of the x-ray in the diagnosis of posterior herniation of the intervertebral disc. *Canad. M. Ass. J.*, May, 1945, 52, 458-470.

This is an excellent review of the subject and includes considerable information concerning the technique of the examination.

The author calls attention to the importance of preliminary routine survey films to exclude

various forms of arthritis, spondylolisthesis, metastatic malignancy and primary involvement of the hip joint.

Oil myelography is advised preoperatively in almost every patient in whom a herniated intervertebral disc is suspected clinically. At least two weeks should elapse after a routine lumbar puncture before the myelogram is performed as peculiar deformities have been encountered in oral studies performed soon after lumbar puncture which later proved to be due to trauma or leakage of subarachnoid fluid into the subdural space.

The author insists that the lumbar puncture needle and syringe should be absolutely dry because even small droplets of water cause decidedly uncomfortable meningeal reactions following the puncture.

The author endorses the use of pantopaque rather than oxygen, air or thorotrast. The roentgen manifestations of these contrast studies of the spinal canal are discussed in detail. The importance of fluoroscopy, spot film exposures, with the patient in the routine anteroposterior and oblique positions is amply demonstrated by many excellent reproductions of roentgenograms. The contrast substance is always aspirated after the study has been completed.

The author calls attention to the fact that multiple disc herniations are not uncommon. Occasionally, spinal cord tumors have been recognized as the cause for the patient's symptoms.

The defects described in the pantopaque column vary considerably. Occasionally, large herniated discs produced minimal changes whereas marked roentgen abnormalities were observed in some individuals with small protruded discs. The importance of the axillary pouch is re-emphasized. The author calls attention to the fact that the width of the spinal canal can be accurately measured by measuring the medial border of the pedicles. He states that the normal subarachnoid space in the lumbar region as outlined by oil must be carefully evaluated and compared to the interpedicular width of the spinal canal.

The illustrations in this article are excellent.—Philip J. Hodes.

#### SKELETAL SYSTEM

BAUMANN-SCHENKER, R. Über Osteomyelosklerosis. (Osteomyelosclerosis.) *Radiol. clin.*, Jan., 1946, 15, 13-14.

This is an unusual bone disease which up to the present time has rarely been diagnosed during life though many cases have been reported from anatomic-pathological examination. It is a diffuse sclerosis of the type of endosteal hyperostosis with many metaplastic new-growths consisting of fibrous marrow. It occurs in the parts of the skeleton that have blood-forming marrow; that is, the spinal column, pelvis, ribs and the proximal parts of the long bones. There is a progressive secondary anemia, and hyperplasia of the liver and spleen; the spleen particularly may become enormously enlarged.

Roentgenologically the disease is characterized by a diffuse thickening of the trabeculae of the spongiosa of the bones of the trunk, though the architecture is not completely lost. Local enlargements of bone such as those seen in Paget's disease and osteoplastic carcinosis of bone do not occur. This makes differential diagnosis from those conditions possible and the disease can be differentiated by careful roentgen examination of the extremities from generalized bone diseases, such as Recklinghausen's osteopathia fibrosa.

The case described was in a man of forty-two who was observed for more than two and a half years. Postmortem examination by the Pathological Institute of Zürich showed a diffuse reticulomatosis which was differentiated with some difficulty from certain leukemic conditions. (Author's abstract.)—Translated by *Audrey G. Morgan*.

BROCHER, J. E. W. Les complications de la greffe osseuse sacrolombaire. (Complications of sacrolumbar bone graft.) *Radiol. clin.*, Jan., 1946, 15, 2-6.

The author describes and illustrates with roentgenograms 6 cases of serious complications following sacrolumbar bone grafts. He does not wish to discredit bone grafting and will continue to advise it in suitable cases. But he calls attention to the fact that if the desired results do not occur the causes of the failure can probably be determined by roentgen examination.—*Audrey G. Morgan*.

MEYERDING, HENRY W., and FLASHMAN, FORREST L. Backache. *J.A.M.A.*, Jan. 12, 1946, 130, 75-78.

The authors call attention to a fairly common lesion of the spinal column that is responsible for low back pain and re-emphasize the impor-

tance of oblique roentgenograms in cases of obscure backache and a weak unstable back. Defects of the isthmic zone of the neural arch are frequently encountered, are sometimes present without producing symptoms and sometimes cause disabling low back pain. Willis found an incidence of 4.28 per cent of isthmic zone defects in 748 skeletons, as reported in 1924 and in 1931.

Defects of the isthmic zone may be congenital, or traumatic, or both, and it is held likely that defects in bony continuity held together by fibrous or cartilaginous tissue may be ruptured by trauma and precipitate backache. The importance of this defect of the isthmic zone has been pointed out as the basis for the condition spondylolisthesis.

Seven illustrative cases of patients who complained of low back pain and were seen during routine examination which revealed typical defects of the isthmic zone are presented. The authors found that a history of trauma may or may not be obtainable. The patients frequently complained of low back pain with extension across the small part of the back, but rarely of pain in the legs. The pain was aggravated by strain. Examination revealed either a normal back or varying degrees of muscle spasm, tenderness and limitation of motion. In some cases there were herniations of the disc associated with the neural arch defects.

Anteroposterior roentgenograms frequently suggest defects of the isthmic zone but seldom show them plainly if at all. When seen they show up just inferiorly to the shadow cast by the pedicles. The lateral view shows a higher percentage of the defects provided they are large enough and in the right plane. The oblique or three-quarter view is extremely important in that it is seldom that a defect cannot be demonstrated in this view if present. The superior articular process, the isthmic zone and the inferior articular process show a "bow tie" shadow on the roentgenogram, and the isthmic zone or the center of the "bow tie" is especially demonstrable on the oblique view.

The majority of patients were treated conservatively with back supports, rest, sleep on a firm bed, and by heat, massage and exercise. Patients not responding to this regimen made good progress after fusion of the spine by means of double bone grafts inserted over the portion in which the defect was situated.—*Charles B. Coburn*.

MUSCOLO, DOMINGO, and PATERSON TOLEDO, ROBERTO. Consideraciones sobre un caso de enfermedad de Schüller-Christian. (A case of Schüller-Christian's disease.) *Rev. de ortop. y traumatol.*, 1945, 14, 183-195.

A case of Schüller-Christian's disease in a girl three years of age is described. One of the three cardinal symptoms of the disease, the diabetes insipidus, was lacking. Roentgen examination showed loss of substance in the left supraorbital and parietotemporal regions, purely osteolytic in nature, without a trace of perifocal reaction; there were similar lesions in the right parietal near the midline. The angle and ascending ramus of the left inferior maxilla were destroyed. The left scapula showed destruction of the superointernal part of the body, of the spine and the acromion process. There was also a small round focus in the subglenoid part of the external border with a moderate perifocal condensing reaction. The pelvis showed extensive osteolytic zones in both iliacs surrounded by foci of reaction. The lesions of the scapula are rare in this disease. Three months and a half of intense radiotherapy caused little change in the picture. There was progressive cachexia without even temporary improvement. The patient was discharged in poor general condition and has not been heard from since.

The intensity of the disease, the enlargement of the liver and spleen and the lack of response to roentgen treatment indicate that the disease was not limited to the bones but had extended to the internal organs. Roentgenograms and photomicrographs are given.—*Audrey G. Morgan.*

GUADAGNI, ALBERT P. Fracture of the first cervical vertebra, complicated by cervical rib. *J.A.M.A.*, Feb. 2, 1946, 130, 276-277.

The author presents a case of fracture of the first cervical vertebra in a forty year old man, the injury produced by a falling grain sack striking the man on the vertex in the erect position.

Although fracture of the first cervical vertebra is rare, the commonest cause is a blow on the vertex of a patient looking forward in an upright position. The fracture is produced by a pressure on the vertex and counter pressure from the spine below; that is, pressure between the condyles of the occiput and the lateral masses of the axis. The weakest point of the atlas lies in the arches and fracture occurs through

these areas with lateral displacement of the fragments. In this case the falling object was soft and produced a pressure injury on the vertebra rather than a direct fracture at the point of contact at the vertex. Hard objects are more likely to produce a fracture of the vertex or a basilar fracture. If the head is inclined forward at the time of impact, the lower cervical vertebrae are more likely to be injured. In the posterior arch the fracture must be differentiated from lack of fusion.

This case was complicated by the presence of a long cervical rib attached to the right transverse process of the seventh cervical vertebra. The fracture of the atlas was at the junction of its posterior and middle thirds; the fragments were in good position. Preliminary head traction was followed by the application of a plaster jacket with helmet included. Later a plaster collar was substituted. Bony union was ultimately complete and near the end of healing a 20 per cent reduction of rotation of the head was present.—*Charles B. Cobern.*

BONFANTE, LUIS M., and DEL SEL, JOSÉ MANUEL. Consideraciones sobre algunas anomalías costales. (Study of some anomalies of the ribs.) *Rev. de ortop. y traumatol.*, 1945, 14, 243-250.

As a rule anomalies of the ribs alone do not cause symptoms and they are only discovered on anatomical, surgical or roentgen examination. But in some cases they are associated with other anomalies of the skeleton or the vascular or nervous systems and in such cases may be capable of clinical diagnosis.

The authors have recently examined some thousands of roentgenograms of the thorax made in examinations for tuberculosis and have found a moderate number of cases of anomalies of the ribs. Roentgenograms of several interesting cases are given. One case of special interest is discussed in some detail. It is similar to one published by Kellogg, Douglas and Linsman in the *American Review of Tuberculosis*. There was fenestration of the first thoracic ribs, leading to confusion with pulmonary cavities. Stereoscopic projections may prevent such a mistaken diagnosis but do not necessarily do so. They advise an apical projection with the tube at an angle of 65° to the head, with the central ray projected anteroposteriorly at the middle of the sternum. The bilaterality of the image is important in diagnosis. It has been suggested

that these supernumerary ribs have a philogenetic significance, that is, that they indicate a tendency to an increase in the number of ribs in the human race. But the authors believe that their association with anomalies of other systems argues against any such significance.—*Audrey G. Morgan.*

SMITH, LESLIE M. Sporotrichosis; report of four clinically atypical cases. *South. M. J.*, August, 1945, 38, 505-509.

The author reports 4 cases of proved sporotrichosis all of whom presented clinical pictures somewhat at variance with the usual conception of the disease.

The average typical case of sporotrichosis begins with an initial nodule or ulcer, usually on an exposed part of the body and spreads to the lymphatics with the formation of a string of nodules which later suppurates. Clinically, sporotrichosis suggests tertiary syphilis and coccidioidal granuloma. The diagnosis of sporotrichosis can only be made with certainty by cultivating the organisms. The intradermal test with sporotrichin is usually positive. A negative skin test is considered rather conclusive evidence against the presence of the disease.

The article includes an interesting roentgenogram revealing a low grade osteomyelitis due to sporotrichosis involving the proximal tibia.

The disease almost uniformly responds favorably to the administration of iodine.—*Philip J. Hodes.*

EGGLI, A. Zur Tomographie der Wirbelsäule. (Tomography of the spinal column.) *Radiol. clin.*, Jan., 1946, 15, 24-29.

Some of the advantages of tomography over ordinary roentgenography in examination of the spinal column are pointed out. In spondylitis, tomography shows more accurately the exact localization and extent of the process and it is often found that it is more extensive than was believed from ordinary examination. In tuberculous spondylitis the focus may develop in the central part of the body of the vertebra and it may require a considerable time for the gelatinous disc to flow into the defect and cause narrowing of the disc. In these cases tomography may give an early diagnosis. With ordinary examination it is often difficult to differentiate between beginning spondylitis and osteochondritic changes. Tomography aids in this differentiation by showing how deep the bone

defect reaches into the body of the vertebra and the outline of its edges. In injuries of the spinal column the tomogram shows details not shown on the ordinary roentgenogram. It gives a plastic picture of the spinal column, its joints and the spinal canal. In cases with compression of the cord it shows the exact localization of the compression. It also shows residues of earlier injuries. In tumors foci of destruction can be shown more accurately and the relation of the tumor to the neighboring tissues cleared up. The tomogram shows the whole arch of the vertebra including the joint processes and even slight changes in these parts. Generally tomographic examination can be dispensed with in osteochondrosis, spondylosis, spondylarthrosis and spondylolisthesis. The changes in these conditions can generally be demonstrated on ordinary roentgenograms with sagittal, frontal and in some cases oblique projections. But even in these diseases tomograms are sometimes useful. Ordinary roentgenograms and tomograms are reproduced which show that sometimes even changes that are visible on ordinary roentgenograms can be correctly interpreted only with the aid of tomograms—*Audrey C. Morgan.*

BAUMANN-SCHENKER, R. Demonstration eines Falles von Ostitis fibrosa localisata. (Demonstration of a case of localized osteitis fibrosa.) *Radiol. clin.*, Jan., 1946, 15, 14-15.

A case was demonstrated in a woman of fifty-five who had never before had any bone disease. On slight trauma she suffered a fracture of the left radius. Roentgen examination in addition to an infraction of the distal end of the radius showed a structural abnormality of the distal two-thirds of the bone, which was swollen and the compact bone thinned; the affected region presented the appearance of a cyst. Toward the proximal end of the bone the clearness passed into an irregular, fine-meshed appearance of the spongiosa. On the suspicion of osteofibrosis an exploratory excision was made, which did not show tumor but an irregular network of bone embedded in fibrous marrow.

Three months after the exploratory excision a roentgenogram showed in place of the former clear, cyst-like area a structure like that of the pictures in Uehlinger's detailed work. It is remarkable that such an extensive transformation of bone should have taken place in a short time in a person of this age and that the typical structures did not develop completely until

after excision. Generalized bone disease was excluded by roentgen examination. The different forms of osteofibrosis and their differentiation from other bone diseases are discussed.

In the discussion Prof. Schinz said that *ostitis fibrosa localisata* was not the correct name for this condition as there was no inflammation. The correct name was *osteofibrosis deformans juvenilis*. Baumann-Schenker acknowledged that this was true.—(Author's abstract.) Translated by *Audrey G. Morgan*.

WEBER, LUIS A., and CARRIÓN, CARLOS J. Angioma vertebral. (Vertebral angioma.) *Rev. de ortop. y traumatol.*, 1944, 13, 205-220.

A case of angioma of the third lumbar vertebra is described and illustrated with roentgenograms. The patient was a woman of twenty-two who presented pain in the lumbar column and slight changes in the reflexes of the lower limbs. Roentgen examination showed the third lumbar vertebra normal in height and shape and the intervertebral discs above and below it normal. But the body of the vertebra showed a porotic appearance and many vertical lines. The development of the process had been very slow. The patient had had pain in the lumbar column since she was fourteen. She was given deep roentgen treatment, 2,880 r in twenty-six days in individual doses of 240 r. At the end of this period the pain had decreased greatly but there had been little change in the nervous symptoms. A plaster cast was applied and she was discharged. She was readmitted in about three months and given another series of roentgen treatments. During this treatment she became pregnant and was delivered normally at term. A year and nine months after her first admission, examination showed little if any lumbar pain, and movements of the spinal column were painless. The nervous symptoms had disappeared completely. The vertical striation was still visible and the porotic appearance of the body of the vertebra had increased. The process had not extended beyond the limits of the vertebra and if it had not been cured had at least been arrested.

These tumors are in themselves benign but may cause serious consequences by pressure on the spinal cord. Roentgen treatment is to be preferred in simple cases in which there has not been too much pressure on the cord. In severer cases laminectomy may be necessary but the mortality is high because of the probability of severe hemorrhage.—*Audrey G. Morgan*.

GRASSER, C. H. Strahlennekrose des Knochens? (Radionecrosis of bones?) *Radiol. clin.*, Jan., 1946, 15, 18-23.

A woman, now forty-four years of age, was irradiated eight years ago for carcinoma of the vagina. She was irradiated three times within a year with a total dose to the skin of 2,160 r. The total depth dose at the focus was about 3,000 r, or 1,000 r per treatment. The irradiation was given by the single dose method of Wintz. Locally the carcinoma was completely healed. But about two years ago she began to have pain on walking or standing which disappeared completely on sitting or lying down. Roentgen examination of the pelvis showed sharply circumscribed bone defects in the horizontal and descending branches of the pubic bone. These could only have been caused by metastases of the tumor or by the irradiation. The roentgen signs, such as sharp boundaries of the defect and symmetry of the lesions, indicated that it was an irradiation necrosis of bone. This was also indicated by the fact that her general condition was good and that for the past eight months the changes in the roentgen picture have remained stationary. The dose was relatively small and the fact that it caused such severe injury indicates that the Wintz single treatment method is much more injurious to normal tissue than the fractional method. The patient also showed severe injuries of the irradiated parts of the skin.—*Audrey G. Morgan*.

BABAIA NTZ, L., and EXCHAQUET, P. Sur un cas d'enchondromatose multiple. (A case of multiple enchondromatosis.) *Radiol. clin.*, Jan., 1946, 15, 7-13.

A young soldier of twenty-three while skiing had a fall which was sufficient to have caused a fracture of a normal bone but on examination, the fracture of the fibula was found in the midst of an area of pathological tissue. Roentgen examination of other parts of the skeleton showed foci of bone destruction in three phalanges of the left foot and the inner border of the first metatarsal, in the left femur and the right forearm which was 6 cm. shorter than the left, lack of the radiocubital joint and an abnormal space between the bones of the wrist and the radius. The distal third of the wrist was swollen and showed chondromatous clear spaces. There was also a deformity of the elbow with displacement of the radius upward. This deformity of the elbow was evidently congeni-



tal. A diagnosis of multiple enchondromata was made. Histopathological examination of a specimen did not show any signs of malignancy. Roentgenograms of the affected bones are given. Schinz describes five forms of chondromatosis, the first and most common affecting the phalanges and metacarpals, the second a systematized chondromatosis of the long bones, a diffuse strictly unilateral chondromatosis known as Ollier's disease, a form affecting a leg or an arm, but always the same region of the body and a generalized disease of the whole skeleton. Illustrations of these forms are given. The case described here was a combination of the first and third forms.

Malignant degeneration may take place in any of these multiple foci without involving the others; the degeneration is generally sarcomatous and the prognosis serious.—*Audrey G. Morgan.*

SMYTH, FRANCIS SCOTT, POTTER, ALICE, and SILVERMAN, WILLIAM. Periosteal reaction, fever and irritability in young infants; a new syndrome? *Am. J. Dis. Child.*, April, 1946, 71, 333-350.

In this paper 7 cases are reported of a condition occurring in young infants, and perhaps in older children, characterized by irritability, fever and anemia with leukocytosis. The most constant observation was a varying degree of periosteal reaction producing new bone and giving a laminated, onion-peel appearance. While strongly suggesting scorbutus, the sites of involvement, the absence of related signs of scurvy, the vitamin C levels and the failure of response to the vitamin, as well as the absence of hemorrhage by biopsy, spoke against vitamin C deficiency.

In 5 of the cases reported, all had a brawny facial edema associated with soft tissue swelling over the mandibular periosteum and had a similar facial appearance.

One of the authors while on the house staff of the Babies Hospital, New York, called attention to a similar group of patients in that clinic. An exchange of data revealed that independently the two clinics has made somewhat similar studies, and in neither place was the causation or exact nature of the disease clearly understood. It was agreed that publication of case reports of both groups would be of value.

Traumatic periostitis, particularly that of the newborn, seemed to be most unlikely and it is

suggested that some of the cases reported under that diagnosis might well be of a nature similar to the authors' cases. Infection, usually mild, of the upper respiratory tract was present in most cases. Cultures of various types, including those from biopsy, showed no recognized pathogen. Specific infections, such as tuberculosis and syphilis, were ruled out. No virus studies were made. The diagnosis of sarcoma was not supported by biopsy nor by the favorable course of the condition under observation over a period of time. Some of the patients showed evidence of mediastinal pathologic conditions. Roentgen therapy over the thymic area was, however, of doubtful value. If the disease was due to stasis of circulation with resultant generalized hyperplastic periostitis, the findings were scant in contrast to the usual clinical basis for pulmonary osteoarthropathy. Fluoride or other poisons seemed to be unlikely causes but were not absolutely ruled out. A metabolic defect was strongly suggested by the rather generalized periosteal reaction and the fact that the biopsy in 2 instances revealed almost identical pathologic changes of muscles, suggesting dystrophy. Because of the extreme irritability and restlessness of the patients, a vague similarity to acrodynia was suggested.

No specific therapy is suggested in the absence of an adequate etiologic explanation of the condition. Sulfonamide compounds were ineffective; penicillin was not tried. Transfusion, massive doses of vitamin C and liver extract by injection seemed to be logical as supportive measures. The prognosis as shown by the authors' cases is good.

In conclusion, they believe that the patients they have studied, those observed in another clinic 3,000 miles distant and many studies reported in the literature, but under varied titles, probably represent a syndrome more extensive than at present recognized.—*R. S. Bromer.*

SHERILL, JOHN D. Carpal bone injuries. *South. M. J.*, May, 1945, 38, 306-312.

The author calls attention to the fact that wrist sprain should not be diagnosed until repeated roentgenograms have proved negative. If pain persists, the examination should be repeated at intervals even though the original films reveal no evidence of bone injury.

The author advocates conservative treatment of fresh fractures of the scaphoid and closed reduction of dislocated semilunar bones.



In the presence of reasonably good wrist function, conservative treatment is also advised for non-union of the scaphoid. Only after adequate conservative therapy has been tried should excision of the carpal bones be resorted to. The fact that many patients with non-union of carpal bones have reasonably good function is re-emphasized. Pain and disability, especially stiffness, are the chief indications for surgery. Before operation, the patient should have the benefit of immobilization to determine whether the pain and disability of the hand will improve. If improvement does not occur, the evidence suggests that the post-traumatic fibrosis and arthritic changes are probably too far advanced to expect a good surgical result.—*Philip J. Hodes.*

VALLS, JOSÉ, VALLS, JORGE E., and SCHAJOWICZ, FRITZ. Reticulosarcoma del radio. (Reticulosarcoma of the radius.) *Rev. de ortop. y traumatol.*, 1945, 14, 169-176.

The authors describe a case of reticulum cell sarcoma of the radius which differs from Ewing's sarcoma in not showing the atypical and monstrous cell forms of that type of tumor.

The patient was a boy who at the age of seven in December, 1940, suffered a slight injury of the right elbow. A roentgen diagnosis of fracture of the radius was made and a plaster cast applied for about a month. After the cast was removed swelling of the part continued and in July, 1941, diagnosis of a fresh fracture was made but the arm was not immobilized. Pain and swelling continued to increase. In November biopsy showed a tumor made up of undifferentiated mesenchymal cells which had invaded both the cortex and marrow cavity.

Roentgen irradiation was given over two fields, anterior and posterior, which were irradiated on alternate days with a dose of 250 r per field. The first series was given between the end of November, 1941, and the beginning of January, 1942. Total dose 2,750 r per field 180 kv., 6 ma., filter 0.5 mm. copper and 1 mm. aluminum; focus-skin distance 40 cm. From the middle of July to the middle of August, 1942, the same treatment was given except that the total dose was 1,250 r per field. The total dose over the two fields for the two series was 8,000 r. A roentgenogram on July 26, 1943, shows almost complete healing of the lesion.—*Audrey G. Morgan.*

LAGOMARSINO, ENRIQUE H. Osteochondritis disecante del astragalo. (Osteochondritis dissecans of the astragalus.) *Rev. de ortop. y traumatol.*, 1944, 13, 221-226.

A case of dissecting osteochondritis of the astragalus in a young man of twenty is described. About two years ago he suffered a slight trauma of the right foot; he was not obliged to go to bed and after a few days was able to walk normally. But after about six months he began to feel pain in the antero-external region of the lower third of the leg and became fatigued easily. Clinical examination did not show any evidence of injury of the ankle but a slight genu varum and pes varus seemed to be a result of the accident. A roentgenogram showed an interruption of the upper border of the astragalus and a further roentgen study in oblique projections with rotation and dorsal flexion of the foot showed the typical picture of König's osteochondritis dissecans, and operation showed that a fragment of bone had become detached by the process at the junction of the anterior three-fourths of the astragalus with the posterior fourth. The body was removed and the patient was able to walk after fifteen days. Now, six months after the operation, there are no further signs of abnormality. Roentgenograms before and after operation are given.—*Audrey G. Morgan.*

POLGAR, FRANÇOIS. Noyaux d'ossification persistants d'apophyses costales du sternum. (Persistent centers of ossification of costal processes of the sternum.) *Radiol. clin.*, Nov., 1946, 15, 377-380.

In 1944 the roentgen image of costal processes of the sternum was first reproduced in this journal. The author reproduces here two roentgenograms of such a case. These two small bones had a distinct cortex and spongiosa and were separated from the manubrium by a definite clear space. They were the size of small peas or beans. From their perfect symmetry, their parasternal location, the fact that the two were of the same size, their bone structure and the narrow cartilaginous fissure separating them from the manubrium, he concludes that they are persistent centers of ossification of costal processes of the sternum.—*Audrey G. Morgan.*

REGAN, JOSEPH M., and CHATTERTON, CARL C.  
Deformities following surgical epiphyseal arrest. *J. Bone & Joint Surg.*, April, 1946, 28, 265-272.

The authors report that in 4 of 36 cases of surgical epiphyseal fusion, carried out according to the technique of Phemister, deformities followed and were directly attributable to the operation. These deformities resulted from incomplete and asymmetrical arrest of epiphyseal growth and often necessitated further surgical intervention. The 4 cases are reported in detail. One developed varus deformity and 3, valgus deformity of the knee.—*R. S. Bromer.*

LIECHTI, A. Über die Schädel-Lokalisation der fibrösen Dysplasie der Knochen. (Fibrous dysplasia of bone localized in the skull.) *Radiol. clin.*, July, 1946, 15, 191-214.

The bone most frequently affected in fibrous dysplasia of bone is the femur. The skull and phalanges of the fingers are least frequently affected. But Pugh has recently extended the conception of fibrous dysplasia to include leontiasis ossea in which only the skull is affected. The author agrees with Pugh that leontiasis ossea is a form of fibrous dysplasia occurring in the skull and describes and illustrates with roentgenograms 7 typical cases. There are two forms of leontiasis ossea, one localized in the form of osteoma and the other more diffuse. The disease begins in childhood and is thought to be a congenital defective development of the bone marrow with primary fibrosis of the marrow. It has not been definitely proved that hyperostosis cranii interna belongs in this group of diseases.

In both types the bones are thickened. In the first type the bones of the base of the skull, the upper cervical vertebrae, the facial bones and in some cases the lower jaw show eburnation, or ivory-like sclerosis. In the other group the bones of the vault of the skull and in some cases the lower jaw become less dense in structure or trabecular, with persistence of the diploe of the vault of the skull. In the majority of cases blood calcium is at the upper limit of normal or it may be slightly increased. Phosphorus is normal and phosphatase at the upper limit of normal or slightly above it.

A bibliography of the subject is given.—*Audrey G. Morgan.*

DE GIULI, GIULIO, and DUCCI, LEONARDO.  
Quadri radiologici di varie forme di nanismo. (Roentgen pictures of various forms of dwarfism.) *Riv. di clin. pediat.*, June, 1946, 44, 321-352.

Ten cases of dwarfism are described in detail and illustrated with roentgenograms. On the basis of these roentgen findings the authors suggest a classification of cases of dwarfism into the three groups: 1. This group includes cases of primary and heredodegenerative forms of dwarfism and all cases of definite endocrine origin. The normal processes of growth seem to be accelerated or retarded but there is no roentgen evidence of local changes. There is no disproportion between enchondral and perichondral growth. 2. In this group, at least during the period of development, there are changes in the epiphyseal cartilages with a resultant disproportion between enchondral and perichondral growth. These include rickets, renal and achondroplastic dwarfism and all the forms of chondrodystrophy which may lead to dwarfism. 3. In this group signs of changes in the epiphyseal cartilage are slight and deformities due to weight-bearing or fracture predominate: they include cases due to osteomalacia, osteopetrosis and osteogenesis imperfecta.

This classification is only suggested for further study as the authors' experience is not sufficient to establish it definitely.—*Audrey G. Morgan.*

SOULE, ARTHUR B., JR., Mutational dysostosis (cleidocranial dysostosis). *J. Bone & Joint Surg.*, Jan., 1946, 28, 81-102.

Mutational dysostosis is a condition, frequently transmitted by parents to offspring, which is characterized by multiple, variable, developmental skeletal anomalies. The more prominent and frequent of these anomalies are aplasia of the clavicles, delay in closure of fontanelles and cranial sutures, brachycephalia, prognathism, irregularities in dentition, and structural abnormalities in the bones of the skull, vertebrae, sacrum, pelvis, femora, scapulae, metacarpals, metatarsals and phalanges.

In 1929, Fitchet made an exhaustive survey of available literature on the subject and abstracted all cases reported prior to that time. Soule in this paper reports 6 cases. He searched the literature from January, 1929, through March, 1944, and as a result of the survey of

Fitchet and his own a total of 323 reported cases was obtained. In his paper he gives in considerable detail the hereditary transmission of the disease, the theories of etiology, and the symptoms and physical findings. The 6 cases are reported in full with numerous illustrative roentgenograms. In his comment on the cases, he draws attention to the multiplicity and variability of lesions found in the disease. He agrees with Rhinehart that the term "cleidocranial dysostosis" should be replaced by the more accurate and descriptive term "mutational dysostosis" and believes that the condition should be considered as one in which any or all of the many different defects may occur. This paper is one of the most complete and exhaustive reviews of the condition since that of Fitchet. It contains a very complete bibliography.—*R. S. Bromer.*

PATRICK, JAMES. Fracture of the medial epicondyle with displacement into the elbow joint. *J. Bone & Joint Surg.*, Jan., 1946, 28, 143-147.

Fracture of the medial epicondyle with incarceration in the elbow joint occurs mainly between the ages of ten and seventeen and is often associated with a traction injury to the ulnar nerve. Patrick in his summary of the paper states that in cases of fracture of the medial epicondyle with displacement into the elbow joint, diagnosis often rests mainly on the roentgenogram. A satisfactory anteroposterior view may be difficult to obtain, but if, in the lateral roentgenogram alone, the epicondyle can be seen at the joint level, it may be regarded as being in the joint. Reduction in early cases can easily be accomplished by anesthetizing the patient, gently abducting the forearm on the humerus, and applying faradism to the flexor muscles. Cases unrecognized for more than a few weeks are probably best left alone and not subjected to further reduction by operation. Immediate anterior transposition of the ulnar nerve is unnecessary.—*R. S. Bromer.*

KEY, J. ALBERT. Survival of the head of the radius in a child after removal and replacement. *J. Bone & Joint Surg.*, Jan., 1946, 28, 148-149.

Key reports a case of a patient, a boy of eleven years, who suffered a dislocation of the elbow which had been reduced on the day previous to admission to the hospital. The roent-

genogram of the elbow showed the head of the radius displaced in the posterior portion of the elbow joint. The patient was operated upon approximately forty-eight hours after his original injury. The head which was completely detached was replaced. Key reports the case because he believes it is a clinical example supporting the statement that epiphyses should not be removed in children. If the epiphyses are found to be displaced, they should be replaced, because they may survive, even though they are completely without blood supply.—*R. S. Bromer.*

GURI, JOSE PUIG. Pyogenic osteomyelitis of the spine. *J. Bone & Joint Surg.*, Jan., 1946, 28, 29-39.

This study is based on 48 cases of pyogenic osteomyelitis involving the vertebral body or neural arch, occurring in the cervical, thoracic or lumbar regions. The diagnostic problems presented by these cases the author divides into two main groups: (1) location of the lesion, and (2) determination of its nature. In the latter group, he states the correlation of the stage of development of the infections due to different organisms with changes seen in the roentgenograms is of diagnostic interest.

He describes in detail several clinical syndromes:

1. The *hip joint syndrome* which is characterized by acute pain in the region of the hip joint, flexion contracture and limitation of movement associated with pain, when accompanied by high temperature, toxemia and marked leukocytosis. This leads usually to a tentative diagnosis of acute suppurative arthritis of the hip joint. When general and local symptoms are not so marked, the possibility of a tuberculous coxalgia arises. When hip pain is due to a spinal condition, careful examination of the hip joint reveals three main findings that, as a rule, can be relied upon, namely (1) palpation of the posterior aspect of the hip articulation produces no pain; (2) trochanteric percussion usually produces pain in hip conditions but not in spinal conditions; (3) restriction of motion is usually confined to extension of the thigh. Physical examination of the lumbar spine may then confirm the suspicion of a lumbar lesion by the following findings: (1) presence of a point or circumscribed area of tenderness to pressure over the affected vertebrae associated with local lumbar spasm; (2) marked limitation

of movement of the spine, particularly flexion; (3) pain in the lumbar spine following any attempt at extension of the leg.

2. *Abdominal syndromes.* In cases in which the spinal lesion is a pyogenic osteomyelitis, high temperature, pain, sharp muscle spasm in the right lower quadrant and slight cutaneous hyperesthesia may be the presenting symptoms and the laboratory studies may show marked leukocytosis and deviation of the Arneth index. In only one of the reported cases was it necessary to make a differential diagnosis between acute suppurative appendicitis and vertebral osteomyelitis.

3. *Meningeal syndrome.* In some cases, the osteomyelitic process is characterized by an acute onset of high temperature, malaise, vomiting, headache and clinical signs of meningeal irritation. In other cases the onset is more insidious without elevation of temperature, but with marked generalized spinal pain and positive Kernig and Brudzinski signs. From the symptoms, an acute suppurative meningitis or a tuberculous meningitis is suspected until an analysis of the spinal fluid and the roentgenograms show an osteomyelitic focus, accompanied by a meningeal reaction. Three of the cases presented this syndrome.

4. *Back-pain syndrome.* The author divides this group into three classes: (A) The acute form in which a major symptom was sudden onset of pain in the back, severe and constant, and in the majority of his cases, increasing in intensity and interfering with sleep. In some cases there was radiation of pain to corresponding peripheral segments (chest, abdomen or extremities). All patients were toxic, with high elevation of temperature. Leukocytosis was present and the sedimentation rate was increased. Abscess appeared in 12 of his patients after intervals of one to three weeks following the onset of clinical symptoms. (B) Subacute osteomyelitis of the spine: In these patients the toxemia was mild. In 3 of the 7 in the series, the process started following serious pyogenic infections in other parts of the body (lesion of the upper lip, perinephritic abscess, pyogenic tenosynovitis). In all the patients of this group the tuberculin test was negative. Three cases developed infection, abscess of the epidural space as a complication of osteomyelitis of the laminae. (C) Osteomyelitis of the spine with insidious onset: There were 19 cases in this group. The patients did not have temperature elevation or other general reaction. The pain was

usually sharp and was not relieved by rest. Loss of weight was usually present. The most constant physical finding was limitation of motion of the spine and the detection either by palpation or percussion of an area of localized tenderness.

In the roentgenograms, involvement of the spinous articular and transverse processes was found, and infections of the vertebral bodies were either localized or diffuse. The most frequent problem was to differentiate between pyogenic and tuberculous spondylitis. In the localized forms of pyogenic infection of the vertebral body the lesion was a small circumscribed destructive area, situated close to the epiphyseal ring or the cartilaginous plate. A slight narrowing of the intervertebral disc was present in the first stages of the process accompanied by some atrophy of the bony tissue surrounding the focus of infection. After four to six months sclerosis appeared around the initial lesions and in roentgenographic examinations after periods of five years or more, the only residual abnormalities were irregularities in outline of the previously affected body, a thinning of the intervertebral disc and, in some cases, a localized osteophytic formation.

In the diffuse forms, a fuzziness of the limits of the upper and lower surfaces of the vertebral bodies was noted together with a lessening in their density. This atrophy did not remain long, however. After several months, small spicules of reactive new-bone formation were observed. The atrophy was eventually replaced by a dense sclerosis throughout the entire remaining portions of the two contiguous vertebrae. In some cases a solid bony block between the two finally appeared. In cases of tuberculous spondylitis, marked atrophy, on the other hand, was present for at least two years and was rarely replaced by sclerosis. Block formation was a very late phenomenon, likewise reactive bone formation was rarely found except in cases of tuberculous involvement of long duration and was seen in the lower segments of the lumbar spine where calcification or ossification of the intervertebral ligaments was also evident.

The author discusses in detail the question of increased roentgenographic density in tuberculous spondylitis and states it is erroneous to assume that areas of increased density do not occur in this condition. Cleveland and Bosworth have called attention to the fact that there is a high incidence of sclerosis in human tuberculosis of the spine due to a massive loss

of blood supply. Guri believes that in tuberculous spondylitis of the spine in adults areas of increased density are not frequently found in roentgenograms of living subjects with the exception of patients with secondary infection, huge sequestra, or sudden collapse. Areas of increased density are sometimes seen in children during the very early stages of the disease or during the healing period.—*R. S. Bromer.*

PERRIER, HENRI. Quelques cas de spondylite infectieuse. (Some cases of infectious spondylitis.) *Radiol. clin.*, Sept., 1946, 15, 259-274.

The differentiation between tuberculous spondylitis and spondylitis caused by pyogenic cocci is important and often quite difficult. Eight cases of pyogenic spondylitis are described. In two of them dental and tonsillar foci were found and after the removal of these foci the patients recovered. It is, however, not always possible to find local foci. The outcome of the disease depends on two factors—the virulence of the bacteria and the resistance of the body. The variations in these factors give rise to quite variable clinical pictures.

In general, however, infectious spondylitis is characterized by a rather sudden beginning and repeated attacks of fever which are generally not seen in tuberculous spondylitis. In the infectious form there is violent dorsal pain which decreases quite rapidly. The whole duration of the disease is not more than two to three weeks, while that of tuberculous spondylitis is much more chronic. Blood cultures are not positive often enough to be of great value in differential diagnosis.

Roentgenologically both the infectious and tuberculous forms show thinning and finally destruction of the intervertebral disc adjacent to the bone lesions; this sign appears earlier, however, in the nonspecific form of the disease. The conclusive roentgen argument against the tuberculous nature of the disease is furnished, however by the fact that bone lesions appear three to six weeks after the beginning of clinical signs. They appear much later in the tuberculous form. And later there is a much more abundant production of osteophytes in the pyogenic form of the disease. In some cases of infectious spondylitis the clinical course is slow and gradual, suggesting a tuberculous etiology. But the roentgen signs are so slight as to argue against this etiology. In some cases a considerable

period of observation is required to make the differentiation.—*Audrey G. Morgan.*

v. MEYENBURG, H. Über "Abtrennung" der hinteren Wirbelkörperkante als Ursache von Ischias. ("Detachment" of the posterior border of a vertebra as a cause of sciatica.) *Radiol. clin.*, July, 1946, 15, 215-224.

A case is described in a man who in the autumn of 1943, at the age of thirty-nine, suffered an injury of the right hand, which became infected and suppurated for some time. While he was in hospital sciatica developed and at times he had fever. A roentgen examination in the summer of 1944 showed what was interpreted as a fracture of the posterior lower border of the fourth lumbar vertebra. From the clinical and roentgen findings a diagnosis of spondylitis was made.

The patient died of a pulmonary embolism and histological examination showed what Schmorl calls a "detachment" of the border of the vertebra. There were no signs of inflammation and the detachment had evidently been caused by the patient's daily work. He was a forest worker and accustomed to hard labor and lifting heavy weights. This had forced tissue from the intervertebral disc into the spongiosa of the body of the vertebra at the inner edge of the marginal ridge. That the sciatica was caused by the detachment of the border of the vertebra was proved by the fact that there was an indentation of the cauda equina at the level of the injured vertebra. The findings in some respects were similar to those of hernia of the disc but the finer histological details differed.

The roentgen picture in traumatic detachment is very similar.—*Audrey G. Morgan.*

NIEBAUER, JOHN J. Development of squamous-cell carcinomata in the sinus tracts of chronic osteomyelitis. *J. Bone & Joint Surg.*, April, 1946, 28, 280-285.

Malignant degeneration of the skin which lines sinus tracts is not always readily recognized as a complication of chronic osteomyelitis. The carcinomatous lesions are in some instances large, cauliflower-like epitheliomata extruding from the sinuses; however, the more insidious variety, often unsuspected until the development of metastases, exists deep in the epithelialized cavities. Two cases are reported. Both patients were in the age group in which this complication is most often found. In neither

patient was the correct diagnosis obvious on clinical examination. The skin at the edges of the sinuses appeared irritated from constant drainage. Microscopic examination of the tissue first removed showed only chronic inflammation. In one case, an epithelioma in the unhealed amputation stump led to re-examination and the discovery of the tumor in the amputated portion. In the second case, a specimen obtained by curettage showed no epithelioma. Niebauer states that in suspected cases it is well for the surgeon to perform a biopsy under direct supervision in the operating room and to select several suitable specimens for microscopic examination.

Both patients had tolerated their osteomyelitis well for many years. Their complaints of pain and profuse foul discharge were of several months' duration only. The first patient had a pathological fracture of the femur and bleeding from the sinuses in his thigh. These findings, Niebauer regards as characteristic of carcinoma developing in an epithelialized osteomyelitic sinus tract. Roentgenograms of the two patients, although not diagnostic in themselves, showed a provocative finding of small areas of destruction in the sclerotic bone surrounding the cavities, a roentgen picture which may be the result of extension of the carcinoma.—*R. S. Bromer.*

SWENSON, ORVAR. Biochemical changes in the fracture hematoma. *J. Bone & Joint Surg.*, April, 1946, 28, 288-293.

Although the morphological changes which occur in fracture repair are well known, there is incomplete knowledge of the biochemistry of calcification. Swenson carried out experiments to attempt to correlate the relationship of the pH, the alkaline phosphatase and the inorganic phosphate at the site of fracture before and during calcification. He believes these experiments support the thesis that alkaline phosphatase is involved in the process of calcification as seen in fracture repair. The experimental evidence would indicate that the phosphate-ion concentration is increased, at the site of calcification, by a complex enzyme mechanism in which alkaline phosphatase is involved. This is contrary to the theory of fracture healing proposed by such workers as Stirling and Murray. They postulate that the high local acidity at the fracture site produces an ideal medium for an increase of calcium, and that the subse-

quent change to local alkalinity in the fracture hematoma promotes precipitation of the calcium phosphates. No actual direct measurement of calcium concentration is reported to support this theory. The pH changes may affect the calcium-ion concentration in the fracture hematoma, but there are probably more decisive changes in the phosphate-ion concentration which make possible a precipitation of some form of calcium phosphate.—*R. S. Bromer.*

CROMER, C. D. L., MURPHY, D. R., and GARDNER, C. M. Sarcoid of bone. *J. Bone & Joint Surg.*, April, 1946, 28, 294-298.

The authors report a case of sarcoid of bone in a male patient, twenty-one years of age. The roentgen examination revealed a lesion in the left wrist consisting of small, cyst-like areas in the triangular bone having a punched-out appearance. There were also similar areas in the greater multangular, the capitate, the lower extremity of the radius and the bases of the second and third metacarpals. The joint spaces were free and there was no peculiarity of the soft tissues. The remainder of the skeleton when examined under the fluoroscope showed no pathological changes and the chest also was not involved.

Sarcoid of bone, also known as Jüngling's disease and Boeck's sarcoid, is seen most frequently in young adults, particularly in males. The authors state that their case illustrates most of the points which Jüngling held to be characteristic of sarcoid of bone. The history of trauma they regard as probably incidental. Trauma has not been considered of etiological significance by previous authors. In typical cases, the bone lesions are predominantly in the metacarpal bones and phalanges of the hands and in the metatarsals and phalanges of the feet, but cyst formation in the bones of the carpus is well shown in one of the roentgenograms depicted in Jüngling's second paper. Their patient also had a history of an insidious onset and relative absence of disability in the early stages.

The roentgenographic changes, multiple cysts, fit in well with Jüngling's type 2 lesion. The biopsy specimens were typical of the changes usually described. The absence of caseation and the failure to demonstrate the *Mycobacterium tuberculosis* are characteristic of the disease. The intradermal tuberculin test was negative.

The authors quote Jüngling's three types of roentgen changes: Type 1, a diffuse mottling or speckling of the affected bone with sometimes slight expansion of the cortex. Type 2, a punched-out appearance which gives the impression of translucent cysts in the substance of bone. These areas tend to fuse and to form larger cysts, but seldom involve the periosteum or the joints. The punched-out areas are, however, not cysts in the true sense of the word, but contain semisolid granulation tissue. Type 3, loss of density and a latticework appearance in the substance of the bone, without any alteration of the contour.

In regard to the differential diagnosis, tuberculous dactylitis, leprosy, syphilis, gout and traumatic cysts should be excluded. No specific treatment is known to have any effect upon the disease.—*R. S. Bromer.*

GHORMLEY, RALPH K., MEYERDING, HENRY W., MUSSEY, ROBERT D., JR., and LUCKEY, CLARENCE A. Osteochondromata of the pelvic bones. *J. Bone & Joint Surg.*, Jan., 1946, 28, 40-48.

The authors present a study of 40 cases of osteochondromata observed at the Mayo Clinic from 1910 to 1943 inclusive. In each case the diagnosis was verified by microscopic examination. Sixty-nine operations were performed on these patients. Nine of the patients are known to have died and 8 are known to have had one or more recurrences. In 2 cases, not all of the tumor was removed at the time of operation. In 15 cases, there was no evidence of recurrence when the last follow-up data were obtained. No follow-up data were obtained in 6 cases.

While the generally accepted opinion is that osteomata and osteochondromata are benign lesions, it is recognized that they may sometimes be difficult to eradicate surgically, and at times may apparently become malignant and terminate fatally. The authors regard this as particularly true of lesions of the pelvis. Chondromata of the pelvis should be regarded as serious surgical lesions, especially those that are not well pedunculated and those in the more remote and inaccessible parts of the pelvis. When the tumor is purely cartilaginous in nature, the diagnosis may be extremely difficult. If the tumor is on the inner side of the innominate bone, particularly if it is within the true pelvis, its complete local removal is often difficult or impossible.

In 4 of the 40 patients, definite malignant changes were later found in the lesions. In 16 patients (not included in the 40), microscopic examination revealed that the lesions were malignant at the time the patients were first operated upon. The idea is prevalent that these tumors may go from a benign to a malignant status and in many cases this would seem to be true. In some of the cases of the series, this change has not taken place in spite of several recurrences and operations. In other instances the presence of both benign and malignant regions in the same tumor may explain the apparent discrepancy.

Eleven patients received postoperative radiation therapy. In 7, roentgen therapy was employed; in 2, radium therapy was used; and in 2 both radium and roentgen therapy were used. The authors conclude that the value of such therapy seems doubtful. There was only one case in which it may have done any actual good.

The importance of complete removal by operation is evident when patients are seen in the late stage when the tumor has reached a huge size, with much pain and discomfort, and with very little to offer in way of relief. In those instances in which such removal cannot be accomplished by local excision, interinnomino-abdominal (hindquarter) amputations may be indicated.—*R. S. Bromer.*

GREEN, WILLIAM T., WYATT, GEORGE M., and ANDERSON, MARGARET. Orthoroentgenography as a method of measuring the bones of the lower extremities. *J. Bone & Joint Surg.*, Jan., 1946, 28, 60-65.

A method for measuring accurately the length of the lower extremities by roentgenography is described in this paper. The method was evolved with the following requirements in view:

1. Measurement of the bones should be sufficiently accurate to record the comparatively true lengths at any one examination.

2. The precision of measurement should remain constant for varying bone lengths, in order to compute accurately the true increments of growth.

3. Sufficient detail should be delineated to allow the detection of abnormalities in the bones and visualization of the epiphyseal lines.

The method employs three separate exposures for the lower extremity. The central ray is directed successively over each of the three joints and the three exposures are processed on a continuous film, 14 inches in width



and of any desired length up to 44 inches. The technical factors may be varied between exposures according to the thickness of the soft tissue over each part. A target to film distance to 6 feet is always used.

A tunnel for a long cassette (14 by 44 inches), devised by the authors, has incorporated within it two sliding metal shields which allows an exposure to be made over any one-third of the film, while the other two-thirds is protected from exposure.

The patient is placed on the cassette holder in the supine position, with the hips level and the extremities parallel; straps are fastened over the lower thighs and over the ankles to hold the limbs in proper position.

Three exposures are made in sequence, with the tube centered over the hip, over the knee joint and finally over the ankle, the shields being arranged to permit only exposure of the part desired.

The centering of the tube in each exposure is checked by a long metal marker, placed horizontally at right angles to the side of the cassette. One end, pointing at the level of the joint to be exposed, extends over the cassette far enough to cast a shadow on the film; the other end indicates the position of the tube stand for the exposure. In this way the exact level of focus is permanently recorded on the finished orthoroentgenogram. The distance of 6 feet from tube to film decreases any slight inaccuracy occasioned by imperfect centering.

In teleroentgenography the divergence of the rays from the tube produces considerable magnification, even when a distance of 6 feet from tube to film is used. Although this is the case, teleroentgenograms do allow fairly accurate estimates of the relative lengths of the two extremities at a single examination. However, if used for serial measurements of growth, a variable distortion arises which makes them unsatisfactory since magnification becomes greater with the growth of the individual. In part, the error of magnification can be corrected mathematically by triangulation. Computations are time-consuming, however, and results are inaccurate, since the distances of the bones from the film can only be estimated.

Orthoroentgenograms give a permanent, verifiable record of the lengths of the bones of the lower extremities. In addition, since the whole of both lower extremities is presented on a single film in an orthoroentgenogram, details of the structure of the bones and any factors of deformity can be readily evaluated.

The article contains line drawings of the cassette, positions of the tube and patient, etc., with roentgenograms obtained and a table of comparative measurements of the lower extremities in 20 cases by orthoroentgenography and teleroentgenography.—*R. S. Bromer.*

## ROENTGEN AND RADIUM THERAPY

LESSA, ZUINGLIO THEMUDO. O acido nicotínico no tratamento do mal dos raios. (Nicotinic acid in the treatment of irradiation sickness.) *Rev. paulista de med.*, March, 1945, 26, 135-150.

In some cases irradiation causes profound physical and psychic depression. This is apparently due to a lack of vitamin B<sub>1</sub>. No very effective treatment was known until the introduction of nicotinic acid for this purpose.

The author discusses 65 cases in which he has used this remedy and gives a table showing the details of the treatment and the results. He gives the drug in tablet form, giving a 25 mg. tablet every two hours until a daily dose of 75 to 175 mg. has been given. He has never seen any injurious effects from this dosage. In some cases when the drug was stopped symptoms recurred and treatment was then resumed until they stopped definitely.

If given in too large a dosage or on an empty stomach the drug causes an intense skin reaction and diarrhea. It should not be given until an hour after eating. Among his 65 cases the results were excellent in 40 per cent, good in 38.4 per cent, "normal" in 20 per cent, meaning that the symptoms of irradiation sickness were reduced until they were quite tolerable, and failure in only 1.5 per cent. The drug may be given prophylactically in a dosage of 25 to 50 mg. per day throughout the radiation treatment.—*Audrey G. Morgan.*

GROS, C. M., and GUIBERT, H. L. Comportement des épithéliomas malpighiens cutanéomucueux traités par radiothérapie de contact. (Reaction of malpighian epitheliomas of the skin and mucous membrane treated by contact radiotherapy.) *Bull. de l'Ass. franç. p. l'étude du cancer*, 1946, 33, 101-119.

Contact radiotherapy differs from other methods of irradiation in the distribution of the roentgen energy in time and space. This technique of superficial irradiation is characterized by the short focus-skin distance (2 cm. for the Philips tube used) and the low voltage (50 kv).



The inherent filtration is equivalent to 0.2 mm. aluminum and no other filtration is added. There is a very high energy output at the skin (7,000 r per minute) but it decreases rapidly with depth. At 1 cm. depth the irradiation has only one-fifth of its energy at the surface and at 4 cm. only one-hundredth.

The irradiation may be given in a single dose or fractionated. The authors prefer the former method but the technique of both is discussed and 4 cases described in detail and illustrated with photomicrographs.

The effect of single dose contact irradiation is about the same as that of other forms of irradiation except that it takes place much more rapidly. The chondriosomes show changes in fifteen to thirty minutes after irradiation while with the usual techniques the nuclei and protoplasm do not begin to show signs of degeneration until after twenty to forty-eight hours. The different stages of degeneration follow each other up until the twelfth day and from the twelfth to the sixteenth day the cancer cells are entirely destroyed, while repair of the stroma, which began on the third day, is at its height. By the thirty-eighth day no trace of cancer cells can be found in the granulofibrous tissue of the scar. By the end of a year the restoration of the skin and mucous membrane is practically perfect.

Fractionating of the dose also gives very good results but the authors reserve it for cases in which the single dose is difficult or dangerous. At present this method, which is painless, rapid, effective and gives a barely visible scar, is the best one in the treatment of these tumors.—*Audrey G. Morgan.*

FLORENTIN, P., JACOB, P., and HUN, A. Un cas de radio-dermite ulcéreuse cancérisée de la face d'apparition tardive. (A case of late development of an ulcerous radiodermatitis of the face with malignant degeneration.) *Bull. de l'Ass. franç. p. l'étude du cancer*, 1946, 33, 157-162.

Not many cases of late development of ulcerous radiodermatitis with malignant degeneration have been reported. The authors give brief notes on 4 cases published by Simone Laborde in which the latent period varied from eleven to twenty-one years and 1 by Touraine and Dereu with a latent period of sixteen years.

They then describe a case of their own in a man of forty-five who had been treated by ir-

radiation for sycosis in 1924; he was given six irradiations of a quarter of an hour each. The hair fell out in forty-eight hours and did not reappear; with proper treatment this loss of hair should not occur for several weeks and should be temporary. Evidently the dosage in this case was excessive and because of the absence of filtration contained too large amounts of soft rays. There was no evident bad effect, however, until 1930 when an apparently ordinary ulcer developed on the left cheek. This continued to grow and the right cheek also became ulcerated and in 1945 when he returned for treatment there was a very large ulcer of the right cheek with evident malignant degeneration throughout while the smaller ulcer on the left cheek showed malignant degeneration over only one small area.

On the right side they used diathermo-coagulation under evipan anesthesia, coagulating the whole ulcer. On the left the area of malignant degeneration was coagulated, using ordinary dressings on the rest of the ulcer, which apparently improved under their use. When the scar tissue is eliminated after a month to six weeks they propose to treat the remaining ulceration by contact roentgen therapy. The prognosis is serious even though there is no visible adenopathy. These cases of malignant radiodermatitis often resist all methods of treatment.—*Audrey G. Morgan.*

DEAN, ARCHIE L. Wilms' tumors. *New York State J. M.*, June 1, 1945, 45, 1213-1217.

About 20 per cent of malignant tumors in children are in the kidney. The majority of these are Wilms' tumors, which are congenital, embryonal, mixed tumors. Treatment is unsatisfactory because a case has never been known to be cured after metastasis has taken place and metastasis often occurs before the tumor becomes palpable.

The author treated 20 cases of Wilms' tumor with radiotherapy alone about fifteen years ago. Of these patients 5 are still living and without any evidence of disease five years or more after treatment. Though this is a high percentage of cures this form of treatment is not recommended because it requires many months to completely devitalize the tumor and during this period metastasis may take place. Nor is any functioning kidney tissue preserved for in his cases kidney function has been lost. But the treatment has never caused any constitutional

injury of the child and none of these children developed abnormally. It has been reported that the patients with Wilms' tumor who did best at the Mayo Clinic were treated with a combination of irradiation and surgery. As soon as the primary tumor has been demonstrated the whole body should be searched carefully for metastases. If any are found the tumor is inoperable and should be treated by irradiation alone. Even when the lungs appear to be normal roentgenograms of the chest should be repeated every two or three weeks. If the tumor does not decrease in size after six to eight treatments operation should be performed at once.

Infants are often intolerant of irradiation and if the usual dose of 100 r is followed by nausea 75 r should be given. Blood counts should be made every three or four days and if the white cells fall below 2,000 per cu. mm. transfusions of whole blood should be given. Even with metastases irradiation has a palliative action but the infants practically always die.—*Audrey G. Morgan.*

BÜTIKOFER, E. Erfahrungen mit der Kontakttherapie. (Experience with contact therapy.) *Radiol. clin.*, Jan., 1946, 15, 57-61.

Up to the end of 1944 the author, in collaboration with Hagen, had used contact therapy in 259 cases of skin cancer and precancerous conditions. The treatment was given with a Metalix close irradiation tube with a focus-skin distance of 20 mm., a high surface dosage of 7,200 r/min, rapidly decreasing with depth. The half-value layer with 50 kv. and 2 ma. is 0.016 mm. copper. This makes the method especially valuable for skin tumors but it can also be used for tumors of the vagina and cervix.

A few minutes to a few hours after the irradiation there is a slight reddening and edema of the skin, after two to three weeks an exudative reaction and after two or three months, healing is complete with a soft, whitish, slightly contracted scar.

In 6 cases, or 2.3 per cent, there were local recurrences after four to thirty-eight months. This method should not be used for tumors more than 2 cm. in diameter because with larger tumors the dosage at the edges is too small and there is danger of recurrence. If the distance is lengthened to give a larger field of irradiation the greater deep effect must be decreased by stronger filtration. Special care is necessary in places where there is only a thin layer of vascu-

lar soft tissue, as on the forehead, at the inner angle of the eye and on the ear. There is danger too at sites with an irregular surface on account of the non-uniform distribution of the dosage. In large protruding tumors with an irregular surface the tumor should be removed with the electrocautery before the treatment is given. There is special danger of overdosage in cases that have been given radiation treatment previously. Illustrations are given.—*Audrey G. Morgan.*

GROS, C. M., and GUIBERT, H. L. Comportement de l'épithélioma cylindrique du rectum après radiothérapie de contact. (Reaction of cylindrical epithelioma of the rectum to contact radiotherapy.) *Bull. de l'Ass. franç. p. l'étude du cancer*, 1946, 33, 87-100.

This article presents a study of the effect of contact roentgen therapy on normal intestinal mucosa and on cylindrical epithelioma of the rectum. The findings are freely illustrated with photomicrographs.

The normal wall of the colon is resistant to the action of roentgen rays. In 2 cases perforations of the rectovaginal septum were seen but in both these cases the septum was intensely infiltrated with cancer. The action of roentgen rays on cylindrical epithelioma becomes evident within twelve to eighteen hours and the various stages of degeneration up to the death of the cancer cells can be followed up. Total necrosis of the cancer cells takes place on the twelfth to fifteenth day. Within thirty-five to forty-five days after the first irradiation the cancer tissue is replaced by a tissue which is at first fibroid and then definitely fibrous. This is due to the reticulohistiocytic structure of the rectal mucosa which is much more marked than that of the skin.

Roentgen therapy inside the rectum gives better results than intrarectal radium or external roentgen therapy. If a rectal epithelioma proves particularly difficult to cure it is probably because it has only about the same degree of radiosensitiveness as a skin epithelioma.—*Audrey G. Morgan.*

LAMARQUE, P., and GROS, C. La radiothérapie de contact dans le cancer du rectum. (Contact radiotherapy in cancer of the rectum.) *Bull. de l'Ass. franç. p. l'étude du cancer*, 1946, 33, 76-86.

External irradiation of cancer of the rectum is not successful because the dose required to destroy the cancer cells is larger than that required to destroy the epithelium. The authors have therefore been using Chaoul's method of irradiating with a roentgen tube introduced into the rectum. They have available only a Philips tube, with which the irradiation is emitted from the end of the tube. It is not as good for the purpose as Chaoul's tube which has lateral windows.

In mobile and very accessible nodular cancers they give a dose of 5,000 to 10,000 r per field, as many fields being used as are necessary to cover the cancer. The dose is given in direct contact with the tumor and without filtration. A week later the same irradiation is given with a filter of 1 mm. aluminum. This treatment is repeated two or three times at intervals of a week until all the nodules disappear. It is very well tolerated. The irradiation lasts for only two or three minutes. In infiltrating cancer three weekly irradiations of 5,000 r each are given, filtered with 1 mm. aluminum. Then a free interval of two weeks is given and this sequence repeated for two or three months.

Up to January 1, 1946, 28 patients had been given this complete treatment. Two of the patients died, one of hemorrhage and one from an unknown cause. Specimens from both these cases were examined and did not show a single cancer cell. Two patients now show local recurrence. The other 24 patients have been clinically and histologically cured for from three to twenty months.

To the objection made that this is a blind treatment Lamarque replied that the lesion is seen directly. A rectoscope is introduced and the tumor localized accurately. The tube is then introduced through the rectoscope and the treatment given under direct control of vision. —Audrey G. Morgan.

PEAKE, JOHN D. Radiation therapy in uterine fibroids. *South. M. J.*, July, 1945, 38, 480-485.

The author reviews his experience in 300 patients with uterine myomas with bleeding, of whom 290 were treated by irradiation. Ten refused radiation therapy because of fear.

One hundred eighty-six patients were treated by roentgen therapy; 86 by radium following dilatation and curettage. Eighteen patients received combined roentgen and radium ther-

apy. Those given roentgen therapy received from 1,800 to 3,600 r (measured in air) in approximately two weeks, using rays generated at 200 kv. Eight hundred to 3,000 mg-hr. of radium were given by means of an intrauterine capsule which contained 35 to 50 mg. of radium filtered through 1 mm. of platinum. Of the 290 patients treated, only 2 cases failed to be relieved of the uterine hemorrhage.

Radiation therapy was not used in patients who complained of pressure symptoms or pain. The patients with degenerative tumors were also refused radiation therapy. The fact that patients with predunculated submucous tumors do not respond to radiation therapy is re-emphasized.

In the majority of instances, the bleeding stopped within three weeks to three months. Usually, no menopausal symptoms appeared until after the third month. Approximately two-thirds of the author's patients complained of menopausal symptoms which did not seem unusually severe. In no case was loss of libido observed.—Philip J. Hodes.

GILBERT, R. La radiothérapie fonctionnelle. (Functional radiotherapy.) *Radiol. clin.*, March, 1946, 15, 81-110.

The author discusses what he calls functional radiotherapy, which in contrast with ordinary tumor radiotherapy, for instance, does not cause any histological changes. The results are obtained indirectly by action of the rays either on the vegetative nervous system or on the endocrine glands. It is not effective unless there is a disequilibrium in the vegetative nervous system or in the endocrine glands. There is an analogy between this method of irradiation and surgery of the sympathetic nervous system.

The various conditions in which this method of radiotherapy can be used effectively are discussed. They include the dermatoses, functional disturbances from hyperthyroidism, functional ovarian disturbances, neurocirculatory functional disturbances, pain syndromes, such as sciatica, reflex nervous disturbances following peripheral trauma and various neurovegetative disorders. The technique of the treatment in these various conditions is described. In functional hyperthyroid disturbances, for example, irradiation may be given in the thyroid region, over the hypophysis or over the suprarenal capsules. Among the functional ovarian disturbances that have been treated successfully

are amenorrhea and sterility, dysmenorrhea and disorders of the menopause. Among the neurocirculatory disturbances are high blood pressure, various vasomotor disturbances of the extremities and angina pectoris. In the latter condition irradiation should not be given during the attacks but between them; it decreases the frequency and severity of the attacks. In thrombosis of the coronaries the irradiation dilates the vessels and in this way relieves the pain and probably also favorably affects the blood supply of the myocardium.—*Audrey G. Morgan.*

REIMANN, H. Das Serum-Eisen-Spiegel bei Patienten mit malignen Tumoren vor, während und nach therapeutischer Röntgenbestrahlung. (The serum iron content in patients with malignant tumor before, during and after therapeutic roentgen irradiation.) *Radiol. clin.*, Sept., 1946, 15, 284-287.

The serum iron content of the blood means the amount of iron in the blood outside the hemoglobin molecule. It has been claimed that this is lowered in cases of malignant tumor, but most of the methods used in studying this question have been inaccurate as they have not shown total serum iron, but only certain fractions of it.

The authors examined the question by determining serum iron before, during and after roentgen treatment in 130 cases of malignant tumor, including some of lymphogranulomatosis. Before irradiation, serum iron was found normal in a little more than half the patients, it was decreased in barely an eighth and increased in a little less than a third. During the course of the irradiation serum iron remained normal in more than half the patients, it decreased in about one-fourth of the cases and increased in about one-fifth. Twenty-six patients were examined again a considerable time after irradiation and 15 of these, or 57 per cent, showed normal values, 10, or 39 per cent, decreased values and 1, or 4 per cent, increased values. A table is given showing the details of the results.—*Audrey G. Morgan.*

ZUBIANI, GIULIO. A propos de l'irradiation de la région pylorique dans les syndromes polyglobuliques. (Irradiation of the pyloric region in polyglobulic syndromes.) *Radiol. clin.*, March, 1946, 15, 74-80.

The author discusses roentgen irradiation of

the pyloric region in polyglobulia, or more correctly speaking polycythemia, if we mean by polyglobulia a secondary increase of red blood cells and by polycythemia a primary increase from an unknown cause.

For the past ten years it has been known that there is an intrinsic factor in the stomach that plays a part in hematopoiesis. This factor is produced at the two poles of the stomach, that is to say in the cardiac and prepyloric regions. This has been sufficiently demonstrated to justify the use of stomach resection in polycythemia vera.

The author has tried radiotherapy of the gastroduodenal region in these cases as one of the many functional uses of irradiation. He used it successfully in 3 cases in Milan in 1942 but has not the records of these cases available. He does give case histories and graphs of 2 further cases treated at the Universities of Lausanne and Bâle.

The first patient, a woman of sixty-five, was given a total of 5,500 r in 25 treatments over an anterior and an anterolateral field with compression. Her blood picture was not greatly changed when she was discharged. The second patient, a man of fifty-two, showed polycythemia vera, chronic nephritis and the picture of an old duodenal ulcer. He was given nine irradiations of 300 r each over the pyloric region, a total of 2,700 r. Five months after the beginning of treatment the gastric pain and dizziness had disappeared, and the red cell count had returned to normal. He thinks it an interesting point that the treatment was most successful in the case with gastroduodenal disturbances.

In the discussion Dr. Mathez cites cases of successful radiotherapy of polycythemia vera after unsuccessful irradiation of the bones. He recommends trying this treatment before resorting to resection of the stomach.—*Audrey G. Morgan.*

GERULEWICZ, E. Züricher Erfahrungen der Strahlentherapie des Echinococcus alveolaris der Leber. (Experience at Zurich in the radiotherapy of *Echinococcus alveolaris* of the liver.) *Radiol. clin.*, July, 1946, 15, 230-235.

*Echinococcus alveolaris* is rarer than *Echinococcus cysticus* but it is found quite commonly in the northern part of Switzerland. The treatment also is much more difficult than that of *E. cysticus*. The cases are generally diagnosed

late and the prognosis is about as hopeless as that of malignant tumor. No internal treatment has proved effective and diagnosis is generally made so late that surgery is also hopeless.

Seven cases treated by radiotherapy at the Radiotherapeutic Institute of the University of Zurich are discussed and details given in regard to the length of time the patients had had the disease, and the roentgen dosage. Five of the patients were in a late stage of the disease and treatment apparently had no effect. In 2 cases the treatment evidently had some effect. The first of these patients had had a tumor of the liver for two years that had caused no symptoms. He was given individual doses of 588 and 420 r and a total dosage of 3,192 r. Examination three years after treatment showed that the tumor had not increased in size and the patient had no symptoms. Two years later he died of sepsis which autopsy showed was due to secondary infection of the alveolar foci in the liver. The second patient came for treatment after ten years of symptoms. Exploratory laparotomy showed extensive infiltration of the liver with the parasites. After simple fractioning of a total dose of 9,500 r the symptoms gradually receded and four years after treatment the patient was in good health and free of symptoms.

If radiotherapy is to be effective it must be given in very large doses but in view of the hopelessness of the disease otherwise such treatment is justified.—*Audrey G. Morgan.*

ZUBIANI, GIULIO. Kritische Betrachtungen und neuzeitliche Auffassungen über die Strahlenbehandlung der Ovarialtumoren). (Radiotherapy of tumors of the ovary.) *Radiol. clin.*, May, 1946, 15, 165-186.

Statistical reports in regard to the effect of radiotherapy in tumors of the ovary are not very satisfactory. The author discusses the question in connection with 150 cases, a number of which are described in detail and illustrated with microphotographs.

He concludes that it is impossible to determine the relative radiosensitiveness of the different types of ovarian tumor. Tumors that are quite alike histopathologically show varying degrees of radiosensitiveness.

The dose to the tumor should be 4,000-5,000 r and the roentgenologist should be so thoroughly familiar with the radiosensitiveness of

normal and pathological tissue that the dosage will be given without injuring the former. The irradiation must be continued for years as the development of the tumors extends over years. He believes postoperative irradiation should be given even if the tumor is apparently benign as there may be small areas of degeneration at the boundary between normal and pathological tissue that have been overlooked on histological examination. Cases of long survival after operation and postoperative irradiation are described. The results of irradiation seem to be particularly good in malignant papillary tumors.—*Audrey G. Morgan.*

HELSEL, E. V. A review of one hundred cases of ovarian cancer. *Am. J. Obst. & Gynec.*, Sept., 1946, 52, 435-439.

One hundred cases of ovarian cancer are analyzed:

1. Four per cent were Negroes.
2. The ages of most of the patients were between forty and sixty years.
3. There was a high incidence of sterility in this series, 41 per cent being nulliparous.
4. The most commonly associated pathology was ovarian cyst, fibroid and pelvic infection.
5. The duration of symptoms was so short that about two-thirds of all patients arrived at the hospital when hopelessly involved.
6. All but 5 patients had some type of operative procedure carried out by 18 different operators. In three-fourths of the cases only part of the tumor could be removed; while in one-fourth, all of the tumor seen at the time of operation could be removed.
7. There was an immediate mortality of one-sixth of all cases treated. The survival time was three times as great when all the tumor could be removed.

#### Conclusion.

1. Histologic grading is of little value in prognosis.
2. Symptoms occur so late that early diagnosis is almost impossible.
3. The majority of patients are hopelessly involved when first seen.
4. The degree of removability of the growth plus the use of radiation largely determines the survival time.
5. Postoperative irradiation often increases the comfort and improves the psychologic state of the patient.

6. The curative value of irradiation is discouragingly low.

7. Despite the very discouraging end-results in advanced cases of malignant disease of the ovary, it is the author's impression that removal of the primary growth enables the patient to carry on a life of usefulness in comfort, sometimes for years. This makes the operation worthwhile.—*Mary Frances Vastine*.

MILLER, NORMAN, AND HENDERSON, CHARLES. Corpus carcinoma; a study of three hundred and twenty-two cases. *Am. J. Obst. & Gynec.*, Dec., 1946, 52, 894-903.

From their study of 322 cases of corpus carcinoma, the authors note the following impressions:

1. Preoperative roentgen therapy has proved to be a valuable adjuvant to total hysterectomy and bilateral salpingo-oophorectomy in the treatment of corpus carcinoma.

2. Its use clears up uterine infection, reduces uterine size, and decreases pelvic hyperemia, thereby facilitating operation.

3. Preoperative roentgen therapy has not in any discernible way interfered with wound healing.

4. The three weeks required for its administration is a drawback, but by no means a serious one, since for most patients this is an outpatient procedure.

5. The results obtained from preoperative roentgen therapy warrant its continued use, at least until some other combination or new form of therapy is proved more satisfactory.

6. The use of very high voltage roentgen therapy as a preoperative measure in corpus carcinoma appears promising and should be explored further.

7. Radium, likewise, gives good results, but, on the basis of available data, the authors do not believe the relative merits of preoperative roentgen therapy versus radium can be accurately stated.

8. The authors hold no special brief for any form of therapy. Their interest in and work with deep roentgen therapy as a preoperative measure in corpus carcinoma was entirely with the hope of increasing their survival rate.

Roentgen-ray factors employed were: 200 kv. (peak) radiation filtered by 0.5 mm. copper and 1.0 mm. aluminum, half-value layer 0.9 mm. copper, distance 50 cm., minute output about 50 roentgens, measured in air; two anterior and

two posterior pelvic fields 12 by 15 cm. to 15 by 15 cm. in size. The beam was directed at an angle through each field so as to cross-fire the uterine corpus. Two hundred roentgens, measured in air, were given to each of two fields daily to a total dose of 2,000 to 2,200 roentgens per field.

The radium factors were: brass tandem applicator of either two or three chambers depending on the length of the uterine canal. Total filtration was equivalent to 0.5 mm. of platinum. Each chamber might contain from 30 to 50 mg. of radium. The radium dose per chamber varied from 1,500 to 2,400 mg.-hr., the lower part of this range was employed when a two-chambered tandem was used and the higher part with a three-chambered tandem. Occasionally, vaginal applicators placed in the lateral fornices were also used.—*Mary Frances Vastine*.

TAYLOR, HOWARD C., AND BECKER, WALTER F. Carcinoma of the corpus uteri; end-results of treatment in 531 cases from 1926-1940. *Surg., Gynec. & Obst.*, Feb., 1947, 84, 129-139.

Cancer of the uterus, according to Bureau of Census statistics, caused the death in 1942 of 16,393 American women. Carcinoma of the endometrium is probably responsible for a fifth or more of these deaths.

#### *Summary and Conclusions.*

1. Five hundred and thirty-one histologically verified cases of carcinoma of the corpus uteri were admitted to Memorial Hospital during the period 1926 to 1940 inclusive. The absolute five year cure rate on this unsorted group of cases was 38 per cent.

2. The primary cases of the series numbered 386 of which 39.9 per cent were alive and well at the end of five years. By subtracting the patients lost track of when free of cancer and those dying of intercurrent, unrelated illness, the apparent cure rate for five years is about 45 per cent.

3. Of the secondary cases, there were 30 patients who came to the Memorial Hospital without clinical evidence of cancer and of these there were 20 five year cures. The patients admitted to the service with recurrences numbered 133 and, of these, 24.8 per cent were alive and well after five years.

4. The prognosis in carcinoma of the corpus

depends on 3 factors: (a) the gross extent of the disease; (b) the histologic type; and (c) the type of therapy employed. Analysis of the present series was made to evaluate these points.

5. The effect of the gross extent of the disease is shown by the five year end-results in five specified groups as follows: Group I, uterus not enlarged, 66.6 per cent; Group II A, uterus not larger than a two and a half months' gestation, 37.9 per cent; Group III B, extension of carcinoma beyond uterus, 11.2 per cent.

6. The effect of histologic type is shown by the five year end-results in three classifications as follows: adenocarcinoma, Grades I and II, 47.2 per cent; adenocarcinoma, Grades III and IV, 22.8 per cent; adenocanthomas, 51.3 per cent.

7. The relation of type of treatment to end-results is more difficult to evaluate. In the cases in which hysterectomy was performed a 5 year cure rate of 51.1 per cent was shown, while in the group of patients treated only by radiation the figure was 36.8 per cent. The group with treatment limited only to radiation contained, however, more patients in a relatively advanced stage of the disease.

8. The question of whether the cure rate from hysterectomy is increased when radiation is given in addition could not be answered on the basis of the analysis of this material.

#### *Techniques of Treatment.*

1. Radium: The standard method of treatment has been the intrauterine application of a straight applicator containing radium individually constructed for each case so as to extend from the external os to the top of the uterine cavity. The usual initial dose has been 3,600 millicurie-hours. Patients to have surgery are admitted for hysterectomy six weeks after the radium treatment. Patients in whom surgery is contraindicated and for whom it is hoped irradiation will suffice are now recuretted after a four month interval and further radium inserted or the risk of a hysterectomy is then accepted if cancer is still present. In the earlier part of the period reported, however, patients

treated by irradiation alone were simply observed unless bleeding recurred.

2. Roentgen Rays: Roentgen therapy was at first given with massive doses of 750 r each to four or six portals (14 by 21 cm.) using a 200 kv. machine at 70 cm. with 0.5 mm. copper filtration. More recently, 250 kv. roentgen rays have been used, still with four to six pelvic portals, but with a divided dose, each field receiving eight treatments of 250 r each. Roentgen therapy is now given routinely after the radium in patients treated by radiation only and less regularly after hysterectomy. However, in the years of the series being reported roentgen radiation, when given, was almost without exception, the initial therapeutic procedure.

3. Surgery: The surgical operation employed has almost without exception been a total abdominal hysterectomy with removal of both adnexa. The cervix has been removed with only a small cuff of vagina and no attempt has been made to dissect out the lymph nodes or parametria.—*Mary Frances Vastine.*

GRAHAM, RUTH M. The effect of radiation on vaginal cells in cervical carcinoma. 1. Description of cellular changes. 2. The prognostic significance. *Surg., Gynec. & Obst.*, Feb., 1947, 84, 153-173.

1. Two hundred and six cases of cervical carcinoma in which patients were treated by radiation have been studied by vaginal smear. Both immediate and late changes in the cells in the vaginal secretion have been described. Correlation with studies by biopsy have been discussed. The applicability of this method for study of radiation effect in cervical cancer has been suggested and emphasized.

2. Seventy-three cases of cervical carcinoma have been studied by means of the vaginal smear during and immediately after radiation treatment for possible prognostic significance. They have been classified as good or poor responses. The prognostic accuracy is 88 per cent. The practical application of the method has been discussed.—*Mary Frances Vastine.*

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## CEREBRAL ANGIOGRAPHY\*

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APPROXIMATELY twenty years have elapsed since Egas Moniz of Lisbon<sup>12</sup> published his first report on cerebral angiography. One might have expected a wave of enthusiasm favoring its use in selected cerebral conditions but it was not until recently that cerebral angiography began to be used commonly in the neurosurgical centers of North America. The purpose of this communication is to report our experiences with the procedure in approximately one hundred patients.

Egas Moniz first described cerebral angiography in 1927.<sup>12</sup> This report was followed by his important monograph on the subject in 1931.<sup>13</sup> In 1934 he published a second monograph which was widely circulated in this country.<sup>14</sup>

Löhr and Jacobi<sup>44</sup> developed the procedure independently in Germany in 1931. Contributions from Europe were also made by Bignami and Serra,<sup>4</sup> Trias,<sup>75</sup> Jessen and Licht,<sup>34</sup> Northfield and Russell,<sup>53</sup> Wolff and Schmid,<sup>81</sup> Takahashi,<sup>73</sup> Lorenz,<sup>46</sup> Tönnis,<sup>74</sup> Fischer,<sup>20</sup> Reichert,<sup>63</sup> Ekström and Lindgren,<sup>15</sup> Holm,<sup>30</sup> Sjöqvist,<sup>70</sup> Engeset,<sup>18</sup> and others.

It was not until later that North Americans began to write on the subject. Loman and Myerson,<sup>45</sup> in 1936, were among the

first. Elvidge<sup>16</sup> then published his excellent article in 1937. This was followed by communications from Turnbull<sup>76</sup> in 1939, King,<sup>35</sup> Sanchez-Perez,<sup>65,66</sup> Gross,<sup>24-28</sup> Lowman and Doff,<sup>47</sup> and List, Burge and Hodges.<sup>39</sup>

### TECHNIQUE FOR CEREBRAL ANGIOGRAPHY

The first cerebral arteriogram obtained in the Hospital of the University of Pennsylvania was exposed in 1940. The technique employed was essentially that described by Egas Moniz who advised exposing the carotid artery and injecting it under direct vision. This technique was followed for approximately three years, after which the neurosurgical service under the direction of Dr. Francis C. Grant turned to percutaneous injections of the carotid artery. Govons and Grant<sup>23</sup> published the technique for exposing the carotid artery in their paper on cerebral vascular lesions in the *Archives of Neurology and Psychiatry*, June, 1946. As most of our patients were on Dr. Grant's neurosurgical service, the reader is referred to Govons and Grant's article which describes the method in detail.

Dr. John H. Drew of the neurosurgical

\* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pa. Presented before the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.



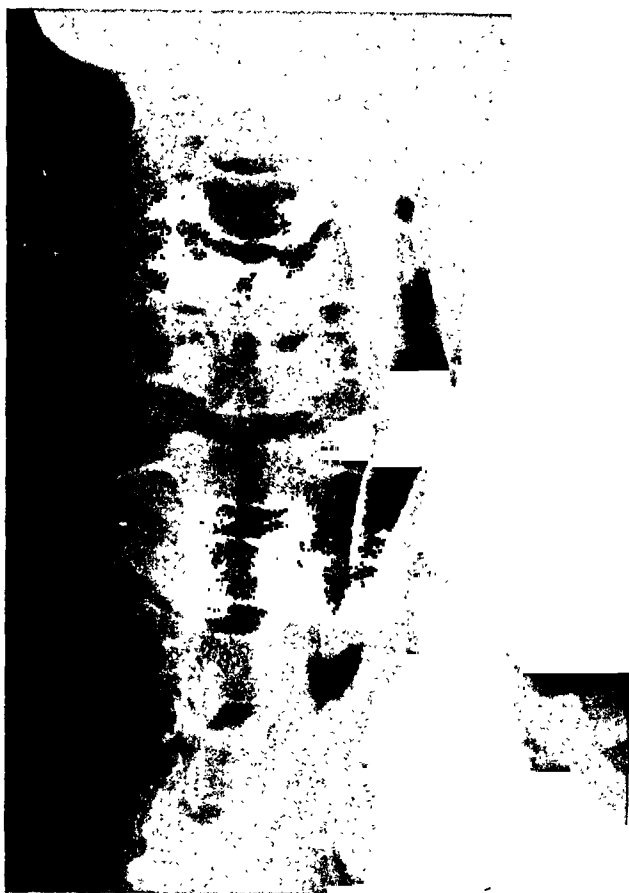


FIG. 1. An anteroposterior roentgenogram of the neck taken following percutaneous injection of the left common carotid artery, showing extravasation of thorotrast around the vessel.

service has been doing the percutaneous injections for the past three years. His technique follows.

In order to assure complete cooperation during the injection patients under fifteen years of age are usually given a general anesthetic; in adults a local anesthetic alone has been used routinely.

The so-called "blind," "indirect," or "percutaneous" injection is done with the patient in the supine position. With the neck hyperextended by placing sandbags or pillows beneath the shoulders, the common carotid artery is fixed against the transverse processes of the cervical spine and the skin prepared for the injection. In adults a No. 18 gauge needle is used; in children a No. 19 gauge needle suffices. As a rule, the needle is introduced through the skin at the level of the cricoid cartilage, the thrust being almost perpendicular to the course of the carotid. Once the artery is

pierced the point is directed cephalad and the needle pushed up the lumen of the vessel for about 2 cm.

Thorium dioxide (thorotrast, 24 to 26 per cent by volume) has been used routinely. Generally, two injections have been necessary, one for the lateral exposures of the head, the second for the anteroposterior views. Usually, in adults, 10 to 12 cc. of thorotrast has been used for each injection. In children the amount injected has been less, 8 cc. being used more commonly.

The injections are made as rapidly as possible. The first film (arterial phase) is exposed just as the injection is completed. The cassette is then changed automatically and approximately four to six seconds later the second exposure (venous phase) is obtained. No attempt has been made to obtain films of the intermediate or capillary phase except in selected instances.

The lateral angiograms having been exposed, the roentgen tube and cassettes are arranged for the anteroposterior projection. With the needle still in the carotid artery, the neck is flexed gently just enough to permit the cassette to be slipped under the head. This movement is hazardous and must be done with extreme caution lest the needle become dislodged causing perivascular extravasation of the thorotrast during the second injection. The injection and the timing of the exposures are the same as described for the lateral views.

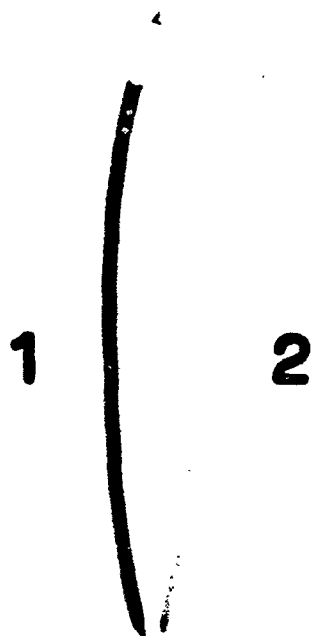
It has been our experience that patients injected after the artery is exposed surgically are examined more easily than those in whom the percutaneous method is used. The head may be handled more easily, and there is less chance for the needle to become dislodged. On the other hand, the surgical exposure is time consuming and may be associated with hemorrhage and infection. It is noteworthy that of fourteen investigators interested in angiography, whose preference of method for injecting the carotid artery was sought, eleven favored surgical exposure. We have had several patients in whom the contrast substance injected percutaneously extrava-

sated into the soft tissues of the neck (Fig. 1). In one individual, the thorotrast was demonstrated in the neck roentgenographically two and one-half years later.

#### CONTRAST MEDIA

Those interested in this field agree that the ideal contrast medium for use in cerebral angiography has not been developed. Slightly more than half of the investigators prefer diodrast.<sup>27,61,72</sup> Of these, the majority advise against using concentrations of over 35 per cent because of the danger of convulsions. Gross<sup>27</sup> has used 50 per cent diodrast without harmful effects in selected individuals. Collins,<sup>7</sup> however, reported death following its use in the one patient in whom it was tried. According to van der Linden<sup>78</sup> diodrast may irritate the carotid sinus and central nervous centers producing severe vasomotor reactions. Though the changes may be transitory he advised against its use in individuals with vasospasm and arteritis. Holm<sup>30</sup> reports that the cerebral arteries appear narrower with perabrodil (similar to diodrast) than with thorotrast. Pendergrass, Chamberlin, Godfrey and Burdick<sup>57</sup> in an exhaustive review of the unfavorable sequelae that follow intravenous urography reported 26 deaths following the use of diodrast intravenously. Since then additional deaths have been reported.<sup>50,51,59</sup>

Most investigators agree that thorotrast is less irritating to the brain than diodrast. In addition it casts a more brilliant shadow in roentgenograms (Fig. 2). Considerable confusion still exists in the literature concerning its radioactive effects in tissue. Selbie<sup>69</sup> demonstrated tumor formation in rats and mice following subcutaneous injections. This is important because extravasations of thorotrast are an unavoidable complication of cerebral angiography. Zifren<sup>82</sup> reported the appearance of a soft tissue nodule in an area through which thorotrast had been injected two years previously. Biopsy revealed fibrotic scar tissue. This complication has not been observed in our patients.



Comparison of the relative density of thorotrast (25% by vol.) and Diodrast (35% by vol.). Tube No. 1 contains Thorotrast. Tube No. 2 contains Diodrast. Exposure made at 50 KVP; 6 MAS; 35" distance; par speed screen; table top.

FIG. 2. Roentgenogram of thin-walled rubber tubes containing thorotrast (25 per cent by volume) and diodrast (35 per cent by volume). Tube No. 1, containing thorotrast, is more radiopaque than tube No. 2, containing diodrast.

In 1935, Northfield and Russell<sup>53</sup> reported findings which provoked considerable discussion. Studying the fate of thorium dioxide solution used in cerebral arteriography, they found microscopic evidence of extensive occlusion of small cerebral capillaries and veins which was associated with localized inflammatory reactions. In addition perivascular edema and degeneration were reported. Ekström and Lindgren's<sup>15</sup> observations seem to support Northfield and Russell's. There is the possibility, however, that thorotrast alone might not have been responsible for the parenchymal changes in the brain, since Bodechtel and Döring<sup>5</sup> found similar damage in patients who had cerebral tumors but had not been subjected to cerebral angiography.

Though less irritating than diodrast,

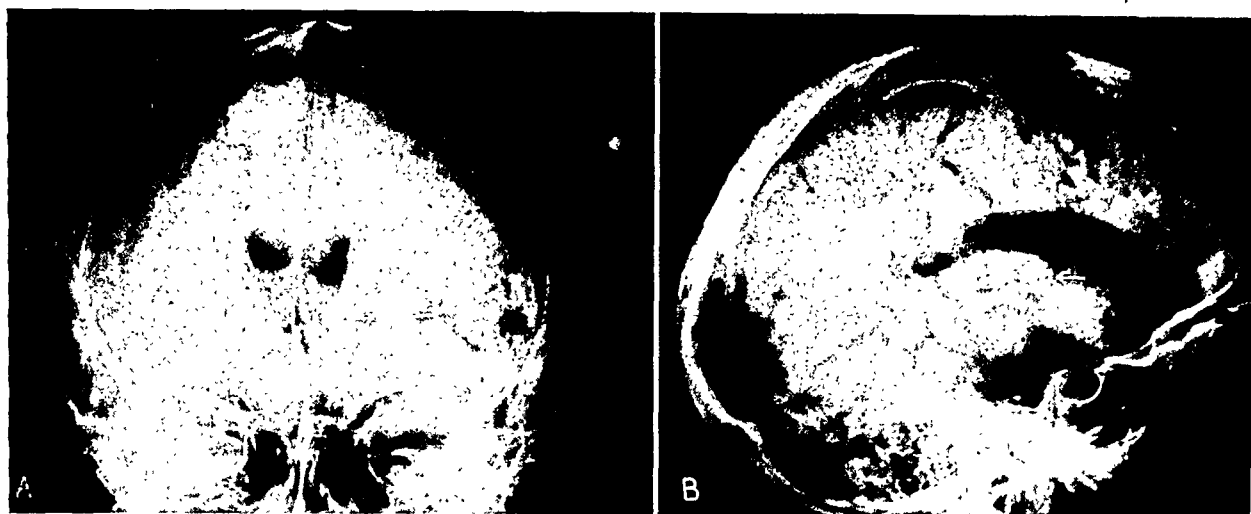


FIG. 3, *A* and *B*. Case XII. Encephalograms of a man, aged twenty-three, with a large arteriovenous angioma in the left cerebral hemisphere. There is a slight shift of the ventricular system to the right. An irregular calcification can be seen (arrows) in both projections.

thorotrast has been known to produce immediate reactions (urticaria, skin and mucosal hemorrhages, chills, headache, diarrhea, and asthmatic attacks). At least two deaths have been reported immediately following thorotrast injection.<sup>19,79</sup> It is only fair to state, however, that as yet the literature contains no record of other permanent clinical ill effects attributable to thorotrast as used in cerebral angiography.

The patients included in the present communication were all injected with thorotrast. This medium was selected because it was less irritating and more radio-paque than 35 per cent diodrast. We have had no reactions to thorotrast. One of the authors (R.A.C.) used 35 per cent diodrast in another institution with equal satisfaction.

Häussler, Döring and Hämmerli<sup>29</sup> used colloidal tri-iodo-ethyl stearate for cerebral angiography without ill effect. We know of no one in North America who has reported using this contrast medium.

#### INDICATIONS AND CONTRAINDICATIONS

The indications and contraindications to cerebral angiography are gradually being formulated. Egas Moniz<sup>14</sup> advocated the procedure for all intracranial lesions. North Americans, however, have tended to be more conservative.

It is Elvidge's opinion<sup>17</sup> that cerebral angiography is indicated in all suspected

aneurysms, angiomatous formations, in tumors causing compression of the internal carotid artery, and in meningiomas and glioblastoma multiforme. We agree with Elvidge, but use it also in tumor suspects in whom routine air studies of the brain fail to depict the lesion. On several occasions we have found small tumors which we failed to localize with air alone. This has been especially true in angiomas (Fig. 3 and 4) and small metastatic lesions.

The contraindications to cerebral angiography merit special emphasis. The contrast media are irritative and toxic. Furthermore, to obtain diagnostic roentgenograms, they must be injected rapidly and under considerable pressure. Thus, their injection into diseased arteries must be considered hazardous. Fortunately, the benefits of an accurate diagnosis overshadow the potential dangers.

Most investigators agree that vascular injections of the brain should not be done during the acute phase of a cerebral accident. Elvidge<sup>17</sup> prefers to wait until the diseased blood vessel has had time to seal itself, usually two to three weeks. Gross<sup>28</sup> waits until the patient has recovered from the acute phase of his illness and the cerebrospinal fluid is clear. King<sup>36</sup> believes that almost all patients die if operated upon during the acute phase of their cerebral accident. He therefore does nothing to

patients suspected of having subarachnoid hemorrhage for at least ten days. Even more conservatism is advocated by Turnbull<sup>77</sup> who waits for two months.

Turnbull,<sup>77</sup> and List, Burge and Hodges<sup>39</sup> consider advanced cerebral arteriosclerosis a contraindication to cerebral arteriography. Nevertheless, occasions will arise when the dangers of the injection in an arteriosclerotic patient must be weighed against the advantages of an accurate diagnosis. Extreme hypertension, senile debility, and cardiac decompensation are also contraindications to carotid injection.

Holm<sup>30</sup> changes his medium from perabrodil to thorotrast in patients over fifty years of age, arteriosclerotic patients, and those in whom angiospastic conditions are suspected. Engeset<sup>18</sup> reports similar usage and avoids perabrodil in psychopathic patients.

#### THE NORMAL ANGIOGRAM

Although numerous variations exist in the distribution of cerebral vessels, their general pattern is more or less uniform and has been described recently by List, Burge and Hodges<sup>39</sup> and Engeset.<sup>18</sup> Therefore, we will describe briefly the normal cerebral circulation and refer the reader to the monographs of Egas Moniz<sup>14</sup> and Engeset<sup>18</sup> for more detailed descriptions.

*Arteriogram* (Fig. 5). The external carotid circulation may be included in the arteriogram when the common carotid is injected, but usually it is easily identified and not to be confused with the internal carotid branches. Stereoscopic roentgenograms will eliminate any uncertainty.

The internal carotid enters the skull through the carotid canal in the petrous apex. It then passes forward in the cavernous sinus, pierces the dura, and curves

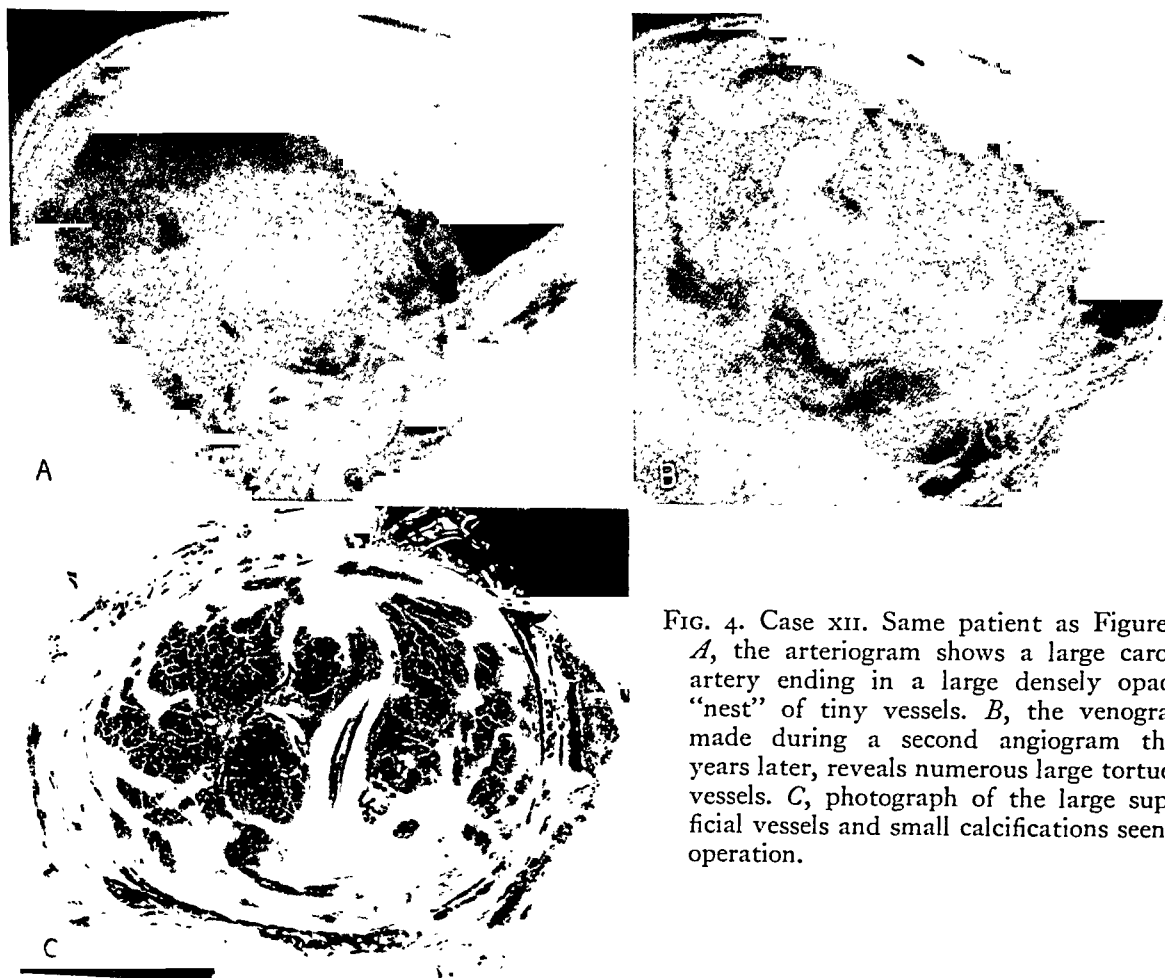


FIG. 4. Case XII. Same patient as Figure 3. *A*, the arteriogram shows a large carotid artery ending in a large densely opaque "nest" of tiny vessels. *B*, the venogram, made during a second angiogram three years later, reveals numerous large tortuous vessels. *C*, photograph of the large superficial vessels and small calcifications seen at operation.

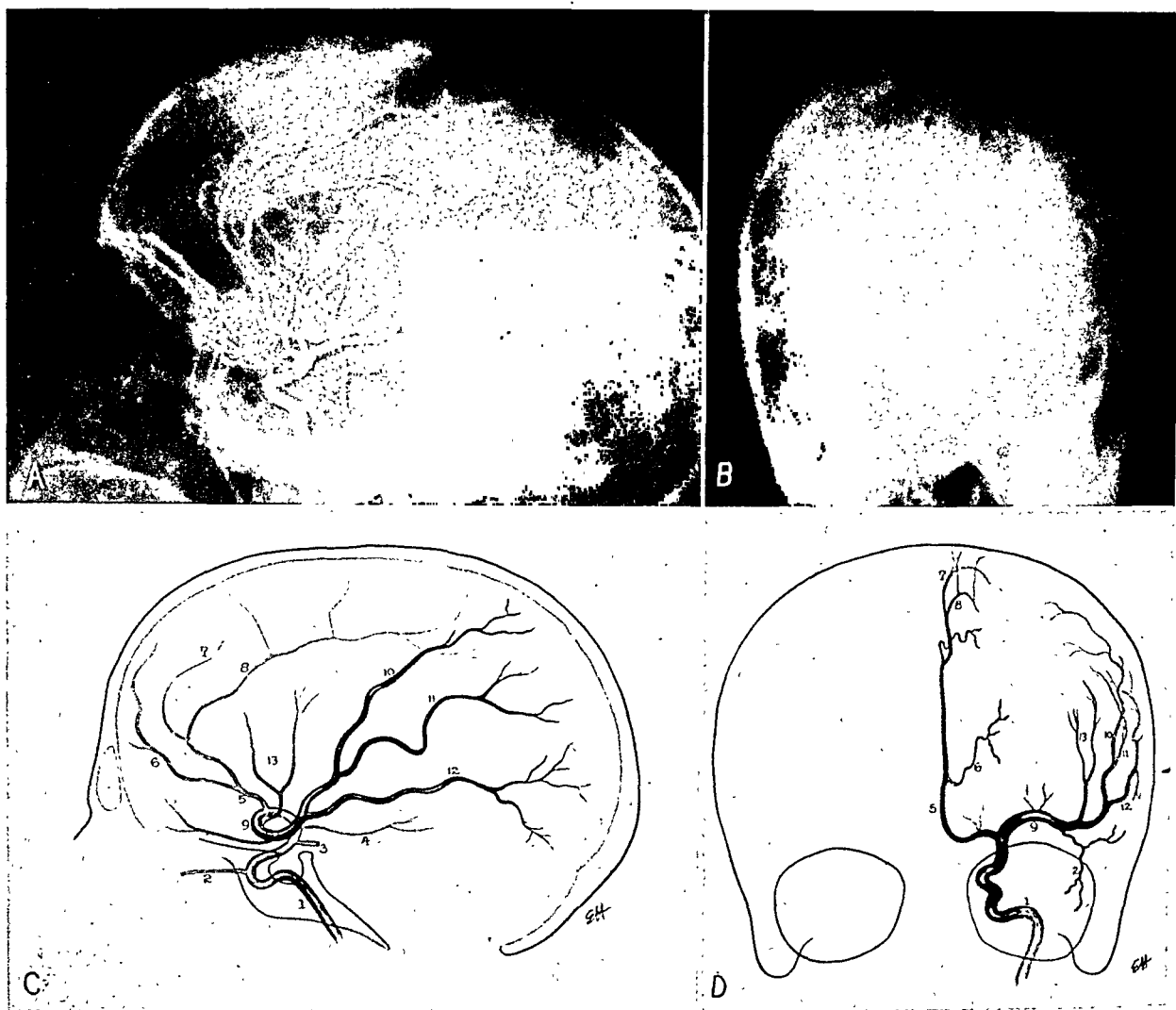


FIG. 5. *A* and *C*, normal lateral arteriogram and drawing (adapted from List). *B* and *D*, slightly rotated anteroposterior arteriogram and drawing.

1, internal carotid artery; 2, ophthalmic artery; 3, posterior communicating artery; 4, anterior choroidal artery; 5, anterior cerebral artery; 6, frontopolar artery; 7, callosomarginal artery; 8, pericallosal artery; 9, middle cerebral artery; 10, posterior parietal artery; 11, angular artery; 12, posterior temporal artery; 13, ascending frontoparietal artery.

backward to bifurcate into the anterior and middle cerebral arteries. The carotid may thus form a single S-curve, a double S-curve, or a transitional form. The first visible intracranial branch is the ophthalmic artery which passes forward beneath the anterior clinoids into the optic foramen. The second branch, the posterior communicating artery, is seldom visualized but may be so large that the posterior cerebral artery becomes a branch of the internal carotid artery. The anterior choroidal artery may then be seen just below the carotid bifurcation. It is small and passes posteriorly between the temporal lobe and

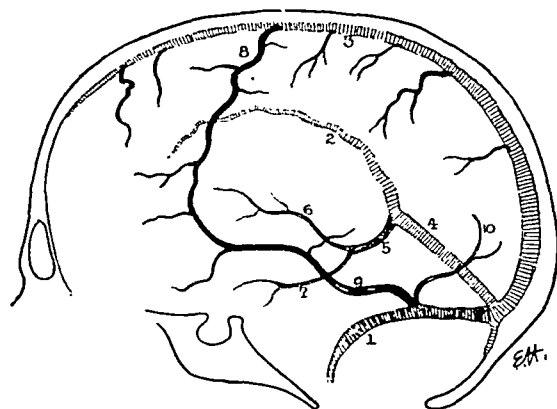
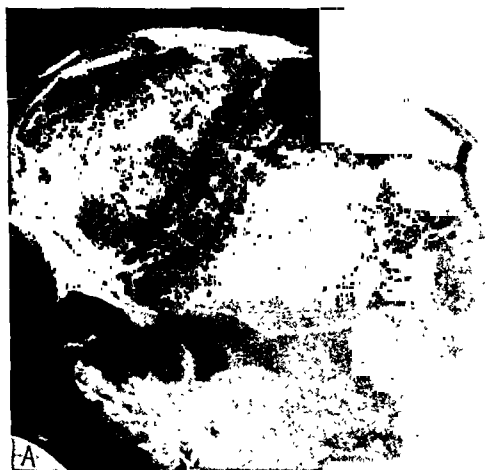
cerebral peduncles to end in the glomus choroidaeum of the lateral ventricle.

The anterior cerebral artery courses medially and forward and gives off the anterior communicating branch which completes the circle of Willis anteriorly. It then turns sharply upward in the longitudinal fissure around the genu of the corpus callosum, giving off the frontopolar artery which passes anteriorly supplying the medial surface of the frontal lobe. As the anterior cerebral artery curves posteriorly, the terminal branches are formed. These are the pericallosal which extends posteriorly in the callosal sulcus, and the callosomarginal

which lies in the cingulate sulcus. The pericallosal artery follows the curve of the splenium of the corpus callosum and may anastomose with the posterior cerebral artery. Occasionally the callosal branches are formed at a much lower level near the bifurcation of the carotid.

The middle cerebral or sylvian group may arise from one or two trunks, which extend laterally in the sylvian fissure and then posteriorly and upward over the island

bral or anastomotic veins. The superior cerebral veins are variable in number,<sup>38</sup> five to thirteen, and drain the surface of the hemispheres, emptying into the superior sagittal sinus. The anastomotic veins of Trolard and Labbé are frequently visualized. The vein of Trolard empties into the superior sagittal sinus. The vein of Labbé, continuing from the middle cerebral vein, passes inferiorly and posteriorly across the temporal lobe to the transverse sinus.



B

FIG. 6, *A* and *B*. Cerebral venogram and drawing (adapted from List.) 1, transverse sinus; 2, inferior sagittal sinus; 3, superior sagittal sinus; 4, straight sinus; 5, great cerebral vein of Galen; 6, internal cerebral vein; 7, basal vein of Rosenthal; 8, anastomotic vein of Trolard; 9, anastomotic vein of Labbé; 10, descending inferior cerebral (temporo occipital) vein. The ascending superior cerebral veins are not numbered.

of Reil. The largest ascending branch, the ascending frontoparietal artery, supplies the lower frontoparietal region. The three major branches of the middle cerebral group run diagonally posteriorly and upward over the lateral surface of the cerebral hemisphere. They are the posterior parietal artery, supplying the parietal lobe, the angular (parietotemporal) artery supplying the supramarginal gyrus, the angular gyrus and adjacent parietooccipital areas, and the posterior temporal artery, which supplies the superior and posterior portions of the temporal lobe.

*Venogram* (Fig. 6). The venous system includes the superficial cerebral veins, the deep cerebral veins, and the venous sinuses. The superficial cerebral system consists of the superior cerebral and the inferior cere-

The deep cerebral veins drain the basal ganglia and empty into the straight sinus. The internal cerebral veins, two in number, are formed near the foramina of Monro and extend posteriorly in the tela choroidea of the third ventricles. The basal veins of Rosenthal pass around the cerebral peduncles and empty into the internal cerebral veins just before they join to form the great cerebral vein of Galen beneath the splenium of the corpus callosum. The great cerebral vein is short, lies in the midline, and empties into the straight sinus at an acute angle.

The superior sagittal sinus occupies the attached margin of the falx cerebri and terminates in the torcular Herophili (confluence of the sinuses) where it joins the transverse and straight sinuses. The infe-



FIG. 7. Case xvi. Carotid arteriogram of a male, aged thirty-five, with a large meningioma in the right frontoparietotemporal region. Note the well outlined tumor stain with several large nutrient arteries apparently ending abruptly at the edge of the tumor area. The supraclinoid portion of the carotid siphon is displaced posteriorly and superiorly and there is elevation of the middle cerebral vessels (arrows), indicating involvement of the temporal lobe.

rior sagittal sinus is contained in the inferior margin of the falx and is continuous with the straight sinus. The straight sinus is situated at the junction of the falx cerebri and tentorium cerebelli and runs diagonally downward to empty into the torcular Herophili or, occasionally, directly into one of the transverse sinuses.<sup>55</sup> The transverse sinuses run lateralward in the transverse and sigmoid grooves of the posterior cranial fossa, curving downward to empty into the internal jugular veins.

*Capillary Phase.* Routine roentgenograms of the capillary phase were not obtained because of technical difficulties in changing cassettes. When visualized the capillary phase is characterized by a diffuse and uniform opacity of the brain. Not infrequently small arteries and veins may be superimposed upon this opacity. Sanchez-Perez<sup>65</sup> and Egas Moniz,<sup>13</sup> as well as others, considered it important to obtain exposures during the capillary phase when occasional characteristic "tumor stains" may be obtained. Egas Moniz believed the meningioma "tumor stain" to be highly diagnostic (Fig. 7).

#### ANATOMICAL VARIANTS

Dandy, in his monograph on intracranial aneurysms,<sup>8</sup> included a chapter on the embryology and anatomy of the circle of Willis, by Padget, which should be read by those interested in cerebral angiography. It includes numerous diagrams which illustrate variations in the circle of Willis and its branches. Differences in caliber and indeed the complete absence of certain vessels were reported.

Extreme anatomical variations included complete unilateral absence of the internal carotid artery as well as bilateral absence in a patient who died of a cerebral hemorrhage. The absence of the carotids in the latter had been compensated for by an enormous basilar artery.

Inequalities in the anterior cerebral arteries are not rare. Actual fusion of these vessels has been observed. Occasionally the pericallosal branch may abandon its regular curve above the corpus callosum and pursue a tortuous course. The callosomarginal branch of the anterior cerebral is rarely the single artery diagrammatic illustrations lead one to suspect. Instead it is usually made up of a group of arteries.

Variations in the middle cerebral artery are also not uncommon. Its three main branches may arise near its origin through two or three trunks. Occasionally the middle cerebral pursues its course as a single vessel, branching only in its terminal portions.

#### THE ABNORMAL ANGIOGRAM

*Intracranial Aneurysm.* The importance of cerebral angiography in the recognition and localization of intracranial aneurysms cannot be over-emphasized. Actually it is the only certain method of making that diagnosis preoperatively and it is the only hope one has of identifying multiple intracranial aneurysms before operation or death.

Before the advent of cerebral angiography the presence of an intracranial aneurysm was often first suspected at the operating table. It was not unusual for

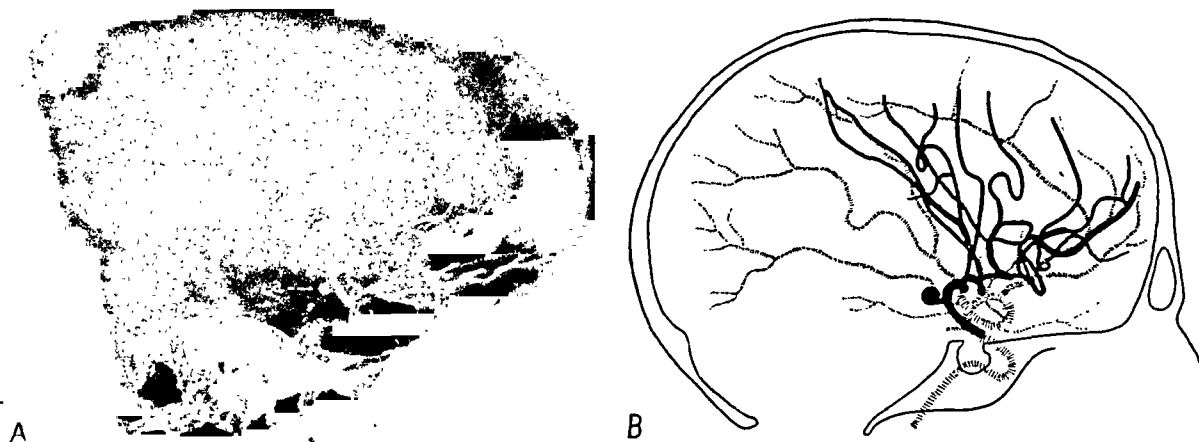


FIG. 8, *A* and *B*. Case I. Arteriogram and drawing of a woman, aged twenty, with a small "berry" aneurysm, *a*, of the internal carotid artery. The upward displacement of the middle cerebral group (arrows) was due to hemorrhage into the region of the sylvian fissure.

neurosurgeons to explore the environs of the hypophyseal fossa for a tumor only to find an aneurysm. Once recognized, its surgical care was often hazardous and uncertain.

Important information is unquestionably obtained from angiography albeit Dandy<sup>8</sup> felt it was often unnecessary. The exact location and frequently its size may be defined before operation. In many instances the relationship of the aneurysm to the neighboring blood vessels in the circle of Willis can be visualized, making its dissection less difficult.

In most clinics cerebral angiography is limited to injection of the carotid artery. Except in rare instances this fails to fill the vertebral and basilar arteries. One may therefore overlook aneurysms in the posterior fossa unless studied clinical judgment is exercised and the vertebral arteries injected in suspected cases.

That most intracranial aneurysms are congenital in origin (80 per cent) is now commonly accepted. Less common are the arteriosclerotic aneurysms and least common those of mycotic origin.

The congenital aneurysms are usually found in young individuals. They are "berry" or saccular in outline with a narrow neck which most frequently arises from the intradural portion of the carotid or from the circle of Willis and its branches (Fig. 8 and 9). It is now generally believed that

these aneurysms arise at the site of primitive embryological vessels which have been incompletely absorbed, leaving "nubbins" on the arterial trunks which later enlarge and become aneurysmal.<sup>6,8</sup> As expected, coexistent congenital abnormalities of other portions of the body have been described. Forster and Alpers<sup>21</sup> reported an aneurysm of the basilar artery in a thirteen weeks old infant with polycystic kidneys. Parker felt that coarctation of the aorta was the most frequent coexisting malformation.<sup>56</sup> Other anomalies reported in conjunction with these aneurysms include stenosis of the abdominal aorta, hypoplastic kidney, aberrant bile duct cysts of the liver, malposition

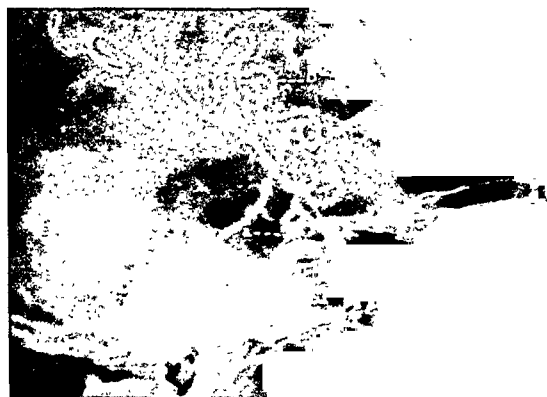


FIG. 9. Case II. Carotid arteriogram of a Negro, aged forty-eight, with small congenital aneurysm, *a*, originating near the anterior communicating artery. A tortuous temporal artery, *b*, is also visualized.



of the adrenals, Chiari's network in the right auricle of the heart,<sup>54</sup> absence of the corpus callosum, arteriovenous angiomas,<sup>71</sup> anomalies of the circle of Willis,<sup>8</sup> and aneurysm of the abdominal aorta.<sup>2</sup>

Arteriosclerotic aneurysms constituted 16 per cent of Dandy's series. Usually they sprang from the larger arterial trunks, enlarged slowly, and were slow to rupture, especially if within the cavernous sinus. Although often fusiform, saccular arteriosclerotic aneurysms occurred not infrequently (Fig. 12).

Mycotic aneurysms are found most frequently in individuals with bacterial endocarditis. They usually involve the middle cerebral artery and, like the congenital aneurysms, tend to rupture early.

The signs and symptoms of intracranial aneurysms may be grouped according to the location of the lesion. As there is considerable overlapping of symptoms, it is often difficult to be certain of their exact location.

The most outstanding symptom of aneurysms in the carotid canal is a sudden severe pain in the homolateral eye and frontal region. This is usually secondary to rupture or sudden expansion and is frequently followed by oculomotor paralysis and trigeminal neuralgia. The remaining extraocular muscles may be paralyzed due to involvement of the fourth and sixth cranial nerves which lie nearby. Loss of vision is also common. Occasionally papilledema, the Foster Kennedy syndrome, and exophthalmos are present.<sup>8</sup>

Aneurysms of the intracranial portion of the carotid produce essentially the same symptoms. McKinney, Acree and Soltz<sup>48</sup> found pain over the eye in all of their patients, as well as paresthesia or hypalgesia in the first division of the trigeminal, ptosis of the eyelid, fixation of the pupil and paresis or paralysis of the oculomotor nerve. Coma is also frequently the initial symptom. Migraine-like headaches are common. According to Dandy<sup>8</sup> subhyaloid hemorrhages in the eyegrounds may be pathognomonic of aneurysms of the circle of Willis.

Rigidity of the neck is common following rupture of intracranial aneurysms. Hemiplegia and convulsions are the usual result when a middle cerebral aneurysm ruptures. Bleeding carotid aneurysms may produce hemiplegias that are incomplete and transient. In the latter the cerebral symptoms are attributed to extension of the hemorrhage up the sylvian fissure. Monoplegias suggest involvement of the anterior cerebral artery, whereas bilateral motor loss is found with aneurysms of the basilar or vertebral arteries. When the posterior cerebral artery is involved it may be accompanied by paralysis of the third, fourth and sixth cranial nerves with contralateral homonymous hemianopsia, visual aphasia, and sensory and motor changes.<sup>8</sup>

Occasionally roentgenologists are alerted to the presence of an aneurysm by curvilinear or irregular calcifications lying lateral and above the sella turcica (Fig. 11). When large enough and strategically placed, the aneurysms may erode the surrounding bony structures. Destruction of the optic foramen, sphenoidal fissure, lesser wing of the sphenoid, as well as the anterior and posterior clinoids, and lateral portion of the hypophyseal fossa is common. As a rule the hypophyseal fossa itself is not much enlarged. In rare instances the pineal is shifted, particularly if the aneurysm has ruptured with the formation of a false sac or hematoma.

#### CASE REPORTS

CASE I (Fig. 8). (Previously reported by Govons and Grant; their Case 1.)

A white woman, aged twenty, first complained of left frontal headaches in August, 1940, and shortly thereafter noticed drooping of the left upper eyelid. On November 10, 1940, she suddenly became unconscious. On recovery she was unable to speak, the right extremities were paralyzed and the neck was stiff. Lumbar puncture, performed at another hospital, showed grossly bloody fluid. She slowly regained ability to speak and the right hemiplegia improved.

Examination at the Hospital of the University of Pennsylvania on November 30, 1940, showed complete ptosis of the left eyelid, with

dilatation and fixation of the pupil. The eyeball was drawn downward and outward. There was no measurable choking of the disc, although the margins appeared hyperemic and blurred. Vision, including the peripheral fields, was normal. There was right hemiparesis with dysarthria, scanning speech, and some difficulty in naming objects. Blood pressure was 118/96. Roentgenograms of the skull showed no abnormalities. An arteriogram of the left side of the brain showed a small berry aneurysm of the internal carotid artery.

The patient was operated on at another hospital on February 16, 1941. On exposure of the brain there was evidence of old hemorrhage, evidenced by an irregular defect in the sylvian fissure and temporal lobe. The aneurysm was isolated and a clip was placed upon the neck of the sac. This was followed by a hemorrhage which necessitated occlusion and cauterization of the internal carotid. Following operation she did well until July 24, 1941, when she lost consciousness for three days. She was subsequently re-admitted to our hospital and diagnosed as pituitary insufficiency with severe hypoglycemia. On January 25, 1942, the patient died. Autopsy revealed atrophy of the pituitary gland, thrombosis of the left internal carotid artery, and generalized sarcoidosis.

*Comment.* Of interest is the fact that this patient presented hemiparesis secondary to hemorrhage in the region of the sylvian fissure. The hemorrhage had spread from the site of the aneurysm and was discovered at operation. The upward displacement of the middle cerebral branches demonstrated in Figure 8 suggested this complication. This aneurysm might not have been visualized if its neck had been smaller or had it contained a clot. As expected the patient had no trigeminal parasthesias or hypalgesias. These symptoms are more common in larger aneurysms which bulge laterally and caudad.

The patient further illustrates the hazards of surgery in this part of the brain where interference with the blood supply and direct injury of the pituitary or hypothalamus are constant threats. It is also noteworthy that microscopic examination revealed no evidence of tissue damage attributable to the thorotrast (36 cc.) in-

jected more than one year before death. Of added interest was the presence of diffuse sarcoidosis.

CASE II (Fig. 9). (Previously reported by Govons and Grant; their Case III.)

A Negro, aged forty-eight, had complained intermittently of pain over the left eye with left frontal headaches for a year. Vision in the left eye had gradually become blurred. Three days prior to admission he had noted double vision with inability to open the left eye.

Neurological examination on the day of his admission to the Hospital of the University of Pennsylvania, July 13, 1942, showed complete ptosis of the left upper eyelid. The left pupil was dilated and fixed and did not react to light or to convergence. The left eye was turned outward, and external rotation was the only movement present. The fundus was normal. The left side of the forehead was hyperalgesic. The spinal fluid was bloody and contained 17,600 red blood cells and 28 white blood cells per cubic millimeter. The pressure measured 220 mm. of water. The serologic reactions both of the blood and of the spinal fluid were positive. Roentgenograms of the skull were normal. An arteriogram of the left side of the brain showed an aneurysm of the internal carotid artery.

*Comment.* The history of headache and pain in the eye followed by the subarachnoid hemorrhage with ptosis and third nerve palsy is rather typical. In this instance the hemorrhage was not large enough to spread up the sylvian fissure and cause hemiparesis. The patient's syphilis probably was not related to the aneurysm.

CASE III (Fig. 10). (Previously reported by Govons and Grant; their Case II.)

A white woman, aged forty-six, was admitted to the Hospital of the University of Pennsylvania on August 24, 1942. Two months before admission she experienced sudden severe headache and lost consciousness for forty-eight hours. On awakening from the stupor, she was oriented but could not open the right eye. At the age of twenty-six she had had a similar attack, suddenly collapsing on the street with severe headache and inability to see. At that time the headache persisted for about one week. Her recovery was uneventful and without neurologic sequelae.

Neurological examination showed complete palsy of the third nerve on the right side. The right eyelid was ptosed, the pupil dilated and fixed to light and convergence, and the eyeball was drawn downward and outward. The disc in the right eye was obscured by a retinal fold which seemed pushed forward by a large subhyaloid hemorrhage. Several other large retinal hemorrhages were present. Other fundal details

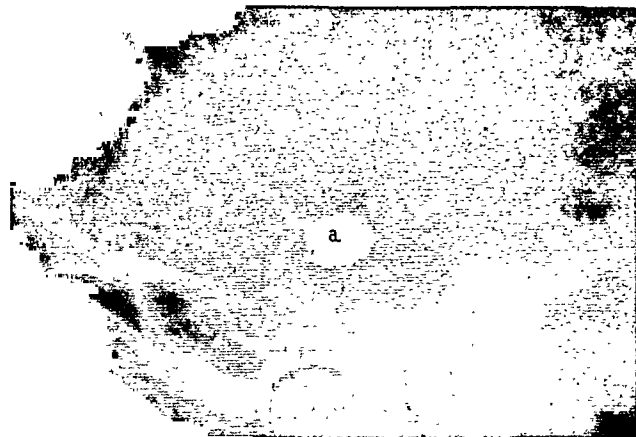


FIG. 10. Case III. Delayed arteriogram of a woman, aged forty-six, with a large aneurysm, *a*, of the supraclinoid portion of the internal carotid artery.

were obscured. In the left eye the disc was normal, the arteries were somewhat attenuated and were irregular, with increased light reflexes and some arteriovenous compression. Several large superficial and deep hemorrhages were present throughout the posterior part of the retina. Visual acuity was 6/9 in the right eye and 6/22 in the left eye. The peripheral fields were full. The remainder of the neurologic examination revealed nothing abnormal. Blood pressure ranged from 127/90 to 160/110.

The medical consultant expressed the opinion that the patient probably had slight hypertensive heart disease. The cerebrospinal fluid was clear and contained 20 red blood cells and 15 white blood cells per cubic millimeter. The protein content was 35 mg. per 100 cc. Serologic tests of the spinal fluid and blood gave negative reactions. Roentgenograms of the skull showed blurring and lack of sharp delineation of the sphenoid ridge on the right side. Otherwise the bones of the calvarium appeared normal. An arteriogram of the right side of the brain showed an intracranial aneurysm, probably of the terminal portion of the internal carotid artery.

On the eighth day of admission a right trans-

frontal craniotomy revealed an aneurysm proximal to the bifurcation of the carotid. There was no definite neck to the aneurysm and the carotid was ligated. Following the operation the patient developed a left hemiplegia. Death occurred one year later but an autopsy was not obtained.

*Comment.* This patient demonstrates the periods of lost consciousness and third nerve palsy that characterize these lesions. The subhyaloid hemorrhage is also noteworthy. Even though the angiogram was exposed late the aneurysm was well visualized, demonstrating stasis within the aneurysm (Fig. 10).

Hemiplegia occasionally follows carotid ligations despite all efforts to avoid it. One wonders whether this could be avoided by complete angiographic investigation of the circle of Willis and its afferent branches.

CASE IV (Fig. 12). (Previously reported by Govons and Grant; their Case IV.)

A white woman, aged sixty-nine, complained of persistent left-sided headaches for five months. Intermittent paroxysms of severe pain, confined to the upper two divisions of the left trigeminal nerve, occurred. Sometimes the pain radiated into the lower jaw. For the past four years diplopia and some drooping of the left eyelid had been noted.

Examination on May 1, 1941, showed that the left eye could not be abducted and that the left palpebral fissure was smaller than the right. The corneal reflex was diminished on the left

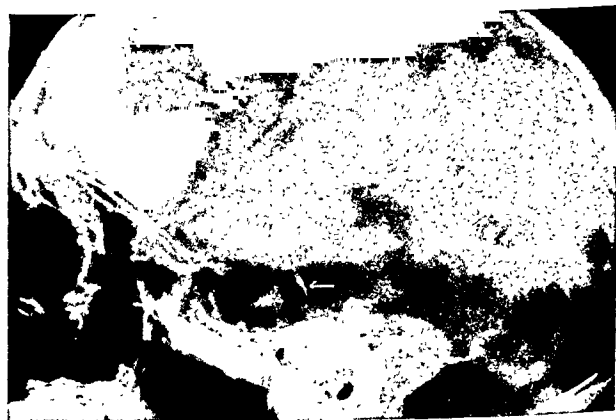


FIG. 11. Routine roentgenogram showing a supra-sellar curvilinear calcification (arrows) in the wall of an internal carotid aneurysm. (Courtesy of Dr. Merrill C. Sosman.)

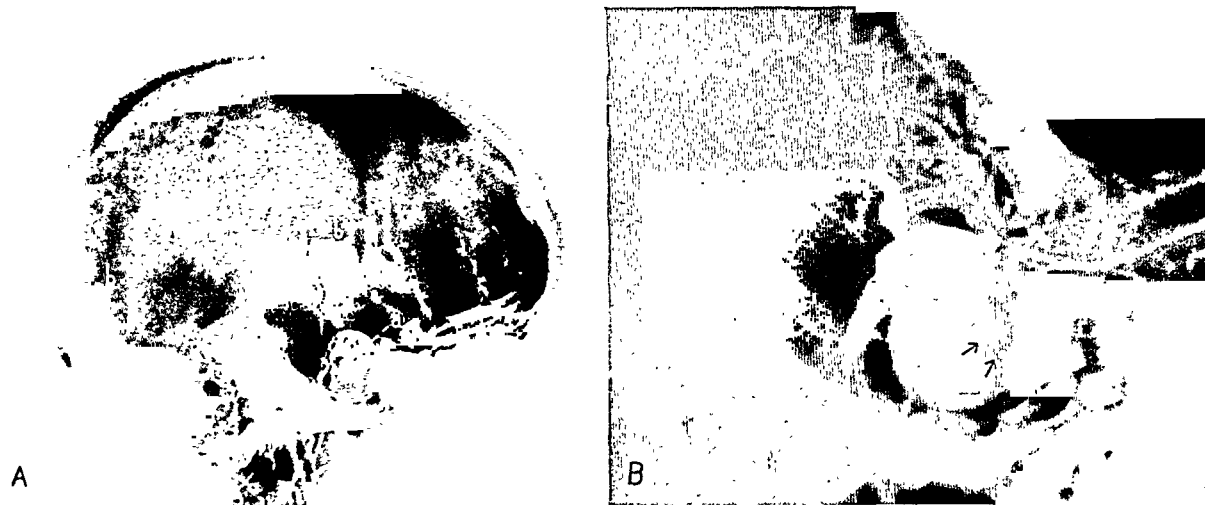


FIG. 12. Case IV. Carotid angiogram of a woman, aged sixty-nine, with a large internal carotid aneurysm in the region of the cavernous sinus. *A*, the arteriogram shows filling of the aneurysms, *a*, and a few tortuous branches of the external carotid artery, *b*. *B*, the enlarged venogram shows delayed visualization of the aneurysm and partial filling of the internal carotid branches. Note the upward displacement of the inferior portion of the carotid siphon (arrows).

side, and the left side of the face was hyperpathic. The left optic nerve appeared pale, and there was mild retinal arteriosclerosis. Visual acuity was 20/70 in the right eye and 20/200 in the left eye. The peripheral field was constricted in the left eye. At times a Babinski sign was elicited on the right side. The cerebrospinal fluid was clear and contained 25 mg. of protein per 100 cc. Roentgenograms of the skull showed slight hyperostosis of the inner table of the frontal bone, a calcified plaque in the falx cerebri, and ballooning of the pituitary fossa. The dorsum sellae was thin, and the left anterior clinoid process could not be visualized. In the basal view, a shadow of increased density to the left of the pituitary fossa was found. The left foramen ovale was larger than the right. An arteriogram of the left side of the brain showed a large parasellar aneurysm of the internal carotid artery.

*Comment.* Large aneurysms such as these usually arise in the cavernous portion of the carotid. Their more common occurrence in old people suggests they may be arteriosclerotic in origin. As a rule the walls of aneurysms in this region are reinforced by the cavernous sinus, making ruptures less likely. Usually the clinical diagnosis before angiography is "parasellar tumor."

The aneurysm in this patient displaced the inferior portion of the carotid siphon up and back. The recognition of this dis-

placement may prove valuable in differentiating these lesions from cavernous arteriovenous fistulas where it is less likely to occur (Fig. 12).

The angiogram also revealed poor filling of the carotid branches. We attributed this to stasis and pressure from the mass of the aneurysm.

CASE V (Fig. 13). (Previously reported by Gobons and Grant; their Case XI.)

A white man, aged thirty-four, was uncon-

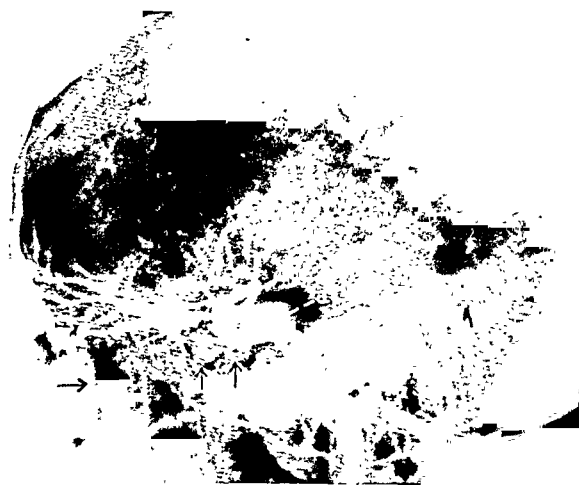


FIG. 13. Case V. Arteriogram demonstrating a cavernous sinus arteriovenous aneurysm, *a*, in a man, aged thirty-four. Note the filling of the carotid branches. The dilated ophthalmic veins can be seen in the sphenoid and orbital regions (arrows).

scious for eight hours after an automobile accident, in December, 1942. On recovery, he noticed a whirring noise in the head, present constantly and synchronous with the heart beat. On discharge from another hospital, nine days later, he complained of headaches, double vision, and spells of dizziness. By the middle of April, 1943, both eyes became bloodshot and began to bulge, the right more than the left.

Examination at the Hospital of the University of Pennsylvania, on June 4, 1942, revealed a head bruit, audible all over the head and without localized intensity. Pressure over either common carotid artery stopped the bruit. There was moderately prominent exophthalmos on both sides, more marked on the right. The conjunctiva was injected in both eyes, with slight chemosis on the right. The right pupil was smaller than the left and reacted sluggishly to light. The right eye showed limitation in abduction and upward movement. There was some limitation of motion in abduction of the left eye. Diplopia was present in all fields. No pulsation of the eyes could be felt. The right disc was blurred but without measurable elevation. Hemorrhages and exudates were present about the disc and throughout the posterior portion of the fundus. The fundus of the left eye was normal. The vision was 6/9 in each eye, and the fields were full. The remainder of the neurologic examination revealed nothing abnormal. Roentgenograms of the skull showed demineralization of the right half of the dorsum sellae and the right posterior clinoid process. An arteriogram of the right side of the brain showed an arteriovenous fistula of the cavernous sinus.

*Comment.* Cavernous sinus arteriovenous aneurysms are not true aneurysms but fistulous communications between the internal carotid artery and the cavernous sinus through which it runs.

Trauma, due to knives or missiles, and fractures of the base of the skull are common causes. Inflammatory disease in the region of the cavernous sinus and arteriosclerosis of the carotid artery are also frequent etiologic factors.<sup>33</sup>

The presence of pulsating exophthalmos and an audible bruit following head trauma is characteristic. The exophthalmos may be bilateral and non-pulsating. In the absence of trauma there may be difficulty in

differentiating these lesions from tumors such as meningiomas which can produce a bruit as well as exophthalmos. Routine roentgenograms may reveal erosive changes similar to those produced by carotid aneurysms. Secondary enlargement of the heart may also be present but is usually less marked than the dilatation noticed when larger arteries are involved in arteriovenous shunts. Case v revealed demineralization of the right half of the dorsum sellae and a notch in the anterior wall of the sella which was probably secondary to pulsation of the anterior intercavernous sinus.

List and Hodges<sup>40</sup> called attention to the fact that patients with cavernous fistulae often revealed little or no filling of the cerebral arteries during angiography. Our patient (Case v), however, revealed fairly good filling of these vessels. Indeed the cerebral arteries were better filled in the latter than in Case iv who had a large carotid aneurysm. This suggests that filling in our patient with the cavernous sinus fistula was due to the fact that the arteriovenous fistula was small, whereas those reported by List and Hodges had large communications.

Dilated tortuous ophthalmic veins are frequently present in cavernous sinus fistulae and their visualization is of diagnostic importance (Fig. 13). The preoperative value of angiography in demonstrating the various types of altered circulation in these fistulae has been previously stressed.<sup>40</sup>

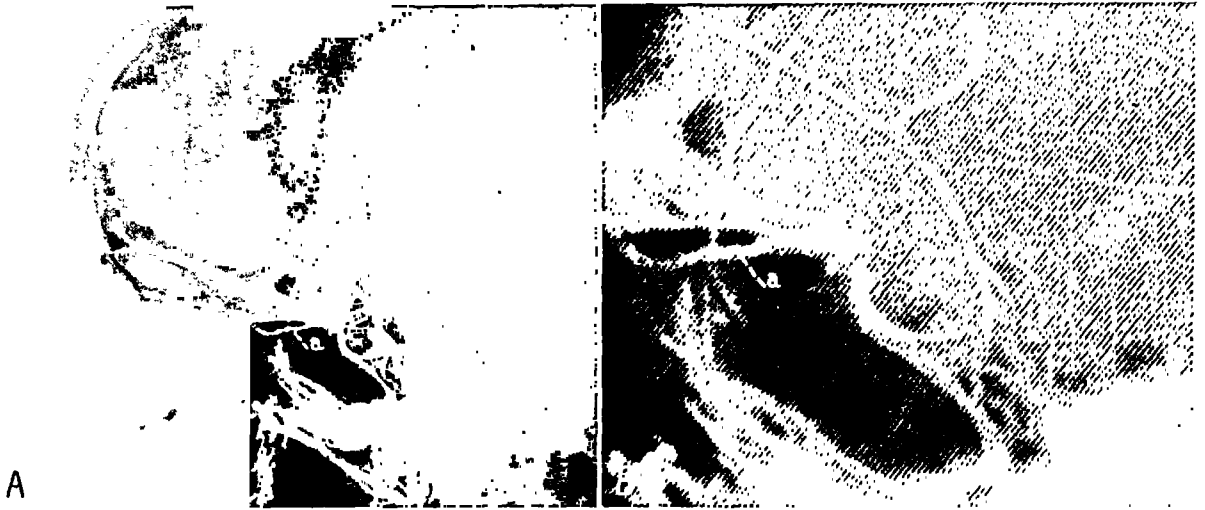
*Cerebral Thrombosis.* Prior to the introduction of angiography thrombosis of the carotid artery was given little consideration and was frequently overlooked. In 1914 Hunt<sup>31</sup> reported 2 cases of thrombosis of the carotid artery in patients with hemiplegia and stressed the importance of palpating the carotid and its external branches for evidence of diminished pulsation. Saphir<sup>67</sup> emphasized the importance of investigating the carotid canal and cavernous sinus for obstruction. Both sites are usually overlooked at autopsy.

If the common carotid is extensively thrombosed angiography is impossible. Thrombosis may be secondary to trauma,

arteriosclerosis, aortic aneurysm or aortic sclerosis, syphilitic and non-syphilitic arteritis and embolism.<sup>31</sup> Symptoms may be absent or there may be progressive hemiparesis and hemiplegia. Encephalograms may show cerebral atrophy or porencephaly.

**CASE VI** (Fig. 14). The patient, a white girl, aged fifteen, was admitted complaining of inability to move the right arm and leg. Two weeks before admission she suddenly developed a severe frontal headache and loss of conscious-

ness of occlusion is the region of the carotid siphon. In Case VI the obstruction was just distal to the origin of the large ophthalmic artery. In rare instances the apparent carotid narrowing seen in some of these patients may be due to spasm. In our case we believe the narrowing might have been congenital. Wolff and Schaltenbrand<sup>80</sup> found that improper puncture of the carotid may cause it to contract and become hard. Spasm of the carotid secondary to the irri-



**FIG. 14.** Case VI. *A*, arteriogram of a girl, aged fifteen, with occlusion of the internal carotid artery (arrow) just beyond the origin of the ophthalmic artery, *a*. The internal carotid is of unusually small caliber. Several external carotid branches, *b*, are visualized. *B*, the enlargement of the arteriogram shows the site of occlusion at the level of the anterior clinoids.

ness for forty-five minutes. On the day before admission she again developed severe frontal headaches which were followed by difficulty in moving the right leg. Her right arm became numb later and it was noted that her speech was slurred.

Physical examination revealed adiadochokinesis, ptosis of the right eyelid, central facial weakness, absence of gag reflex, deviation of the tongue toward the right, right hyperreflexia and hemiparesis with positive Babinski and Oppenheim tests and patellar clonus. An electroencephalogram showed evidence of a mass lesion in the left temporoparietal region.

Twelve days after admission, angiography revealed obstruction of the internal carotid artery in the region of the cavernous sinus. This was confirmed by a second examination five days later.

*Comment.* One of the most frequent sites

tation of dissection has also been observed.<sup>68</sup> Usually application of 1 per cent cocaine solution to the vessel relieves the spasm.

Failure of visualization of the anterior or middle cerebral arteries was observed in several patients in this series. Complete occlusion, however, was diagnosed only when the clinical picture and the roentgen findings were compatible. The diagnosis was never entertained unless the findings were duplicated in a second examination and errors, spasm, and mass lesions were eliminated.

*Angiomatous Malformations.* Less common than cerebral aneurysms or brain tumors, angiomatous malformations lend themselves beautifully to diagnosis by cerebral angiography. Occurring in about 2 per

cent of all intracranial tumors, their preoperative recognition is extremely important due to their unusual vascularity.

Classically these vascular malformations of the brain are divided into three groups: (1) the telangiectases; (2) the venous angiomas, and (3) the arterial angiomas.

The cerebral telangiectases rarely give clinical symptoms and are usually found by accident. Venous angiomas, however, may simulate other brain tumors and in consequence may be first suspected at operation. Occurring usually in younger individuals, they may be composed of one or many dilated thin-walled, non-pulsating veins. Occasionally congenital changes in the ipsilateral eye may be recognized.<sup>32</sup> In some instances they have been found in patients with congenital nevi of the face. Calcifications within the lesions and adjacent cerebral tissues have also been reported.<sup>52</sup>

The arterial angiomas are more serious. Sometimes called "cirroid or racemose angiomas," "congenital arteriovenous aneurysms," or "arteriovenous anomalies or malformations," they may behave as asymptomatic anomalies of the brain or assume more complicated and serious characteristics.

Arterial angiomas always have an arterial inlet, a venous outlet and usually an anastomosing vessel or vessels. The arterial side may consist of one or many large arteries. Indeed most of the arteries and veins of the head may be enlarged. The venous side consists of one or many dilated thin-walled veins which may carry some arterial blood. The anastomosing portion of the lesion is made up of one or many vessels which frequently form a coiled intertwined mass. It is believed that these vascular masses are anomalous attempts to form capillary beds which have failed to develop normally.<sup>33</sup>

Were these lesions purely congenital one would expect symptoms before their usual time of onset in the second or third decade.<sup>32</sup> The evidence suggests that the symptoms are the result of premature degenerative and proliferative vessel changes which

are accompanied by thrombosis and hemorrhage from thin-walled vessels.<sup>61</sup> Expansion of vessels may also be a factor. Obviously trauma could exaggerate or precipitate these changes. In rare instances symptoms may appear in infancy, especially when the malformation involves the veins of Galen which, when dilated, obstruct the aqueduct of Sylvius and cause internal hydrocephalus.<sup>1,33</sup>

Arteriovenous angiomas frequently remain unrecognized clinically. Epilepsy and hemiparesis, headache, increased intracranial vascularity, bruits, and intracranial hemorrhage are the most frequent findings.<sup>52,61</sup> Although any cerebral vessel may be involved, the middle cerebral artery is most frequently affected.

One of the most suggestive findings in these anomalies is nocturnal epilepsy.<sup>62</sup> Occasionally, the epilepsy is associated with hemiparesis and under-development of extremities, a syndrome suggestive of pencephaly and cerebral hemiatrophy. More frequently the hemiparesis follows the convulsions. Migraine-like headaches are common and may occur early. In some individuals the headaches are secondary to subarachnoid hemorrhages and increased intracranial pressure.

Auscultation of the skull is of paramount importance in the examination of every epileptic. A bruit, usually audible in the region of the lesion or over the eyes, may sometimes offer the clue to the diagnosis. Bruits may also be heard over the carotids and may be diminished by pressure upon these vessels. Usually the patient is not conscious of the bruit.<sup>61</sup>

Intracranial vascular malformations may be associated with similar changes in the vessels outside of the skull. The carotid arteries may be enlarged and tortuous. The vertebrals, the arteries of the scalp, and the retinal vessels may exhibit similar changes. Enlargement of the middle meningeal artery is also frequent.<sup>6</sup>

Routine skull roentgenograms occasionally reveal intracranial calcifications. Increased vascularity of the diploe may be

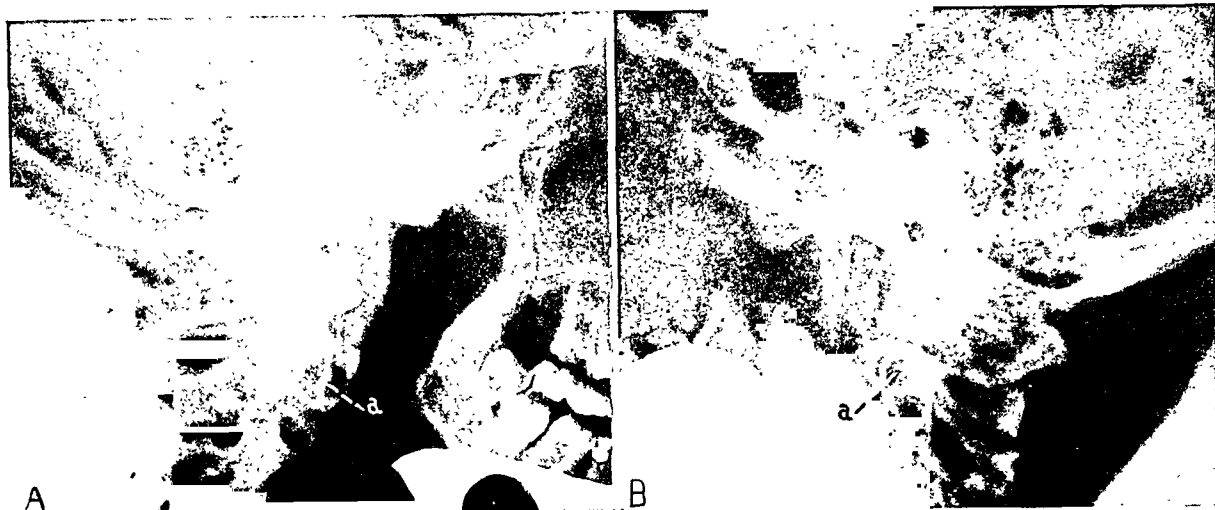


FIG. 15. Case VII. Enlarged lateral skull roentgenograms of a female, aged twenty, with a large arteriovenous angioma in the left cerebral hemisphere. *A*, the left foramen transversarium, *a*, is markedly enlarged. *B*, the right foramen transversarium, *a*, is of normal caliber.

present and dilated superior cerebral veins may cause enlargement of their parasagittal grooves.<sup>38</sup> The carotid canal may be widened by an enlarged carotid artery, the foramen spinosum by a large middle meningeal, and the foramina transversarium by a large vertebral artery (Fig. 15). Small areas of erosion of the inner table are evident when large pulsating vessels are in contact with the bone. Signs of increased intracranial pressure may be evident particularly in complicating intracranial hemorrhage or obstruction of the aqueduct of Sylvius.

CASE VII (Fig. 15 and 16). The patient, a white female, aged twenty, was admitted April 1, 1940, complaining of trembling attacks for four years. She had always noted reduced vision in her right eye. The attacks of trembling were characterized by shaking of the entire

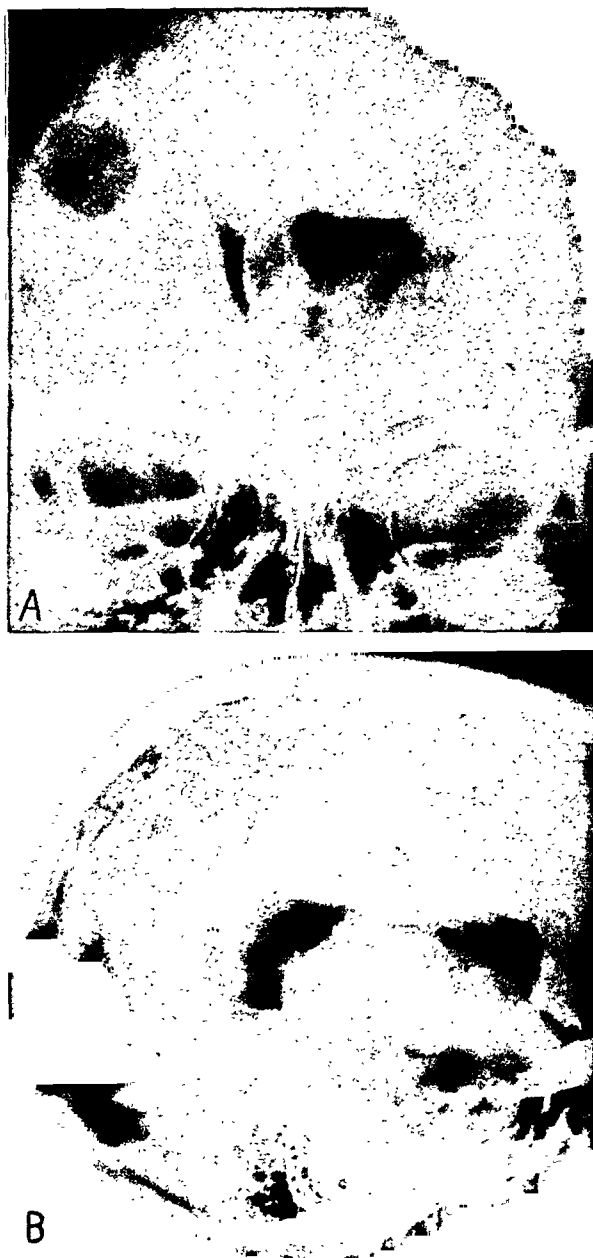


FIG. 16. Case VII. Same case as Figure 15. *A*, in the posteroanterior ventriculogram the midline structures are shifted to the right and the roof of the left ventricle is depressed. *B*, the left lateral ventriculogram reveals a serrated deformity of the roof of the left lateral ventricle which was probably due to the blood vessels in the angiomatous mass.



body and tended to occur around the time of her menses. Increased frequency of the attacks had been noted for several months. In addition, she had had feelings of coldness and numbness of the extremities extending to the knees and elbows.

Physical examination revealed a ptotic right kidney, vision, O.D. 6/60, O.S. 6/6, slight nystagmus on right lateral gaze, hyperactive abdominal, patellar, and Achilles reflexes, right patellar clonus, increased swaying with Romberg test, and a spontaneous "rising reaction"

foramen transversarium of the axis due to the dilated vertebral artery (Fig. 15). Although ventriculography is contraindicated in these patients because of the possibility of the needle puncturing one of the anomalous vessels, the procedure was carried out in this patient because a vascular lesion was not suspected. In addition to the marked ventricular shift and extensive deformity of the roof of the left lateral ventricle, the air studies revealed a *serrated* or

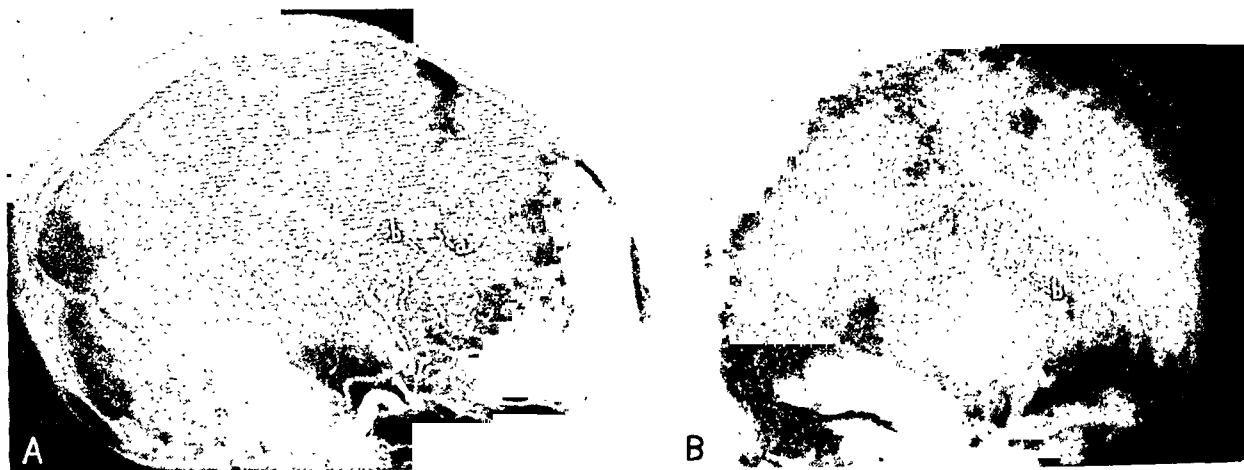


FIG. 17. Case VIII. A male, aged thirty-one, with a small arteriovenous angioma deep in the left cerebral hemisphere. *A*, in the lateral arteriogram the "nest" of tiny vessels, *a*, and anomalous communications, *b*, with the middle cerebral group are visualized. *B*, the anteroposterior projection shows the "nest," *a*, communicating with an anomalous frontopolar branch, *b*, of the anterior cerebral artery.

in which the left leg was raised higher than the right. All other studies were negative except the encephalogram which suggested a mass lesion in the left hemisphere.

A preoperative ventriculogram on April 22, 1940, revealed a mass lesion in the left parieto-fronto-temporal region which produced a shift of the midline structures and deformity of the roof of the left ventricle. A left temperoparietal craniotomy revealed an arteriovenous malformation consisting of several large pulsating veins with small congeries of vessels surrounding two of the large veins. The large veins were tied off but the arterial anastomoses could not be visualized and the wound was closed. The patient's convalescence was uneventful and when seen one month later she had had no further convulsions.

*Comment.* Unfortunately a cerebral angiogram was not obtained in this patient. The routine roentgenograms of the skull revealed marked enlargement of the left

*ripple* outline in the roof of the lateral ventricle which when seen is most characteristic of these vascular lesions (Fig. 16).

CASE VIII (Fig. 17). (Previously reported by Govons and Grant; their Case VII.)

The patient was a white male, aged thirty-one, admitted on December 27, 1944, complaining of convulsive seizures involving the left leg. In 1939 the patient had had an attack of acute frontal headache. This was followed in March, 1940, by convulsive seizures beginning in his face and followed by loss of consciousness. These attacks gradually grew more frequent and more severe.

Physical examination revealed nuchal rigidity, right facial weakness, and hyperactive reflexes in the right leg. The cerebrospinal fluid was xanthochromic and contained many red cells. Angiography revealed a small angioma in the left hemisphere.

*Comment.* This is the smallest arterio-

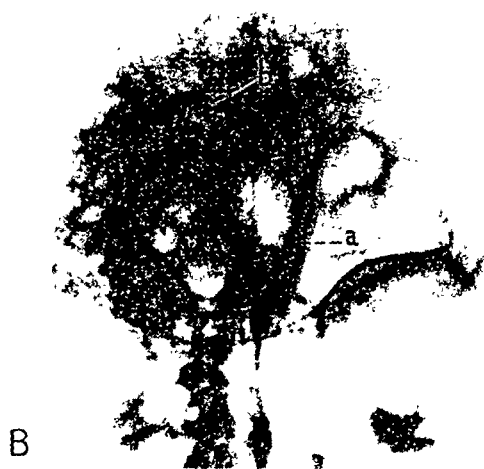
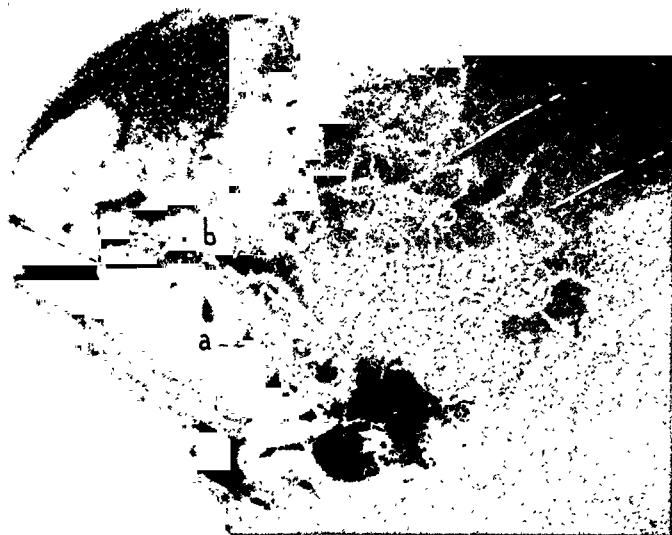
FIG. 18. Case IX. Posteroanterior skull roentgenogram of a white female, aged forty with an anterior fossa arteriovenous anomaly and old subdural and intracerebral hemorrhages. There is demineralization of a portion of the right sphenoidal ridge (arrows) and an irregular "moth-eaten" area, *a*, in the right frontal bone.



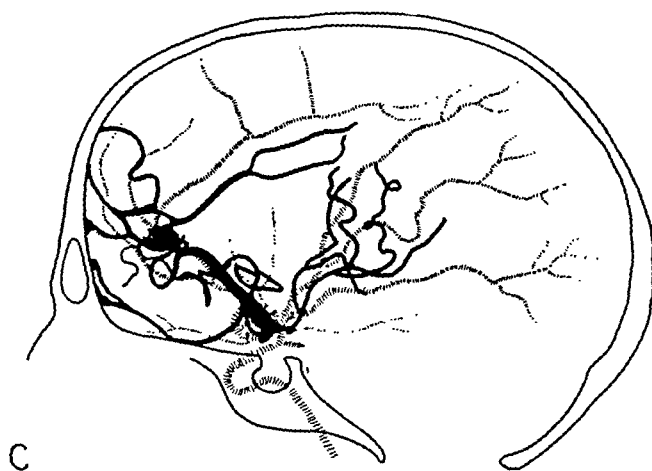
venous angioma in our collection. It apparently communicated with an anomalous frontopolar branch of the anterior cerebral artery as well as a middle cerebral vessel.

CASE IX (Fig. 18 and 19). The patient was a white female, aged forty, admitted complaining of headache, nausea and vomiting, and convulsions for one week. The headaches were in

the right frontal region. Convulsions started on either side of the body and became general.



B



D

FIG. 19. Case IX. Same case as Figure 18. *A*, the right lateral arteriogram visualizes a large anomalous anterior cerebral artery, *a*, a "nest" of tiny vessels, *b*, and several superficial cerebral or meningeal vessels, *c*. *B*, there is marked displacement of the large anterior cerebral artery, *a*, to the left in the anteroposterior arteriogram. A large anomalous vessel, *b*, is also visualized.

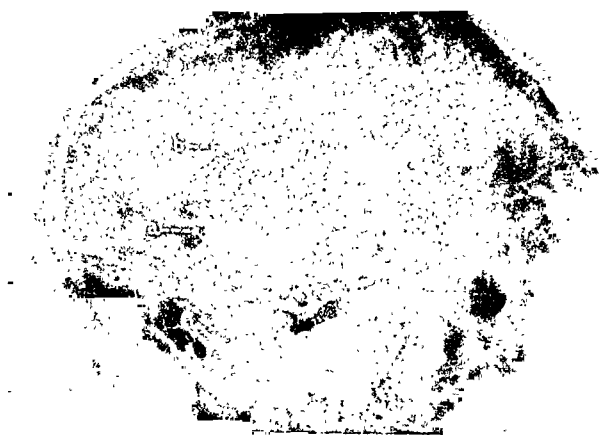


FIG. 20. Case x. A right carotid arteriogram of a male, aged twenty-three, with an arteriovenous angioma in the right temporoparietal region. Innumerable tiny vessels are visualized within the lesion and the anterior cerebral, *a*, and pericallosal, *b*, arteries are larger than normal.

Physical examination revealed a soft mass, probably an angioma, in the right upper eyelid. Neurological examination revealed dysarthria as well as blindness in the right eye. Routine skull roentgenograms showed a moth-eaten appearance in the right frontal bone, demineralization of the right sphenoidal ridge, and enlargement or erosion of the right foramen lacerum. Angiography demonstrated anomalous vessels in the right frontal region. The right anterior cerebral vessel was enlarged and displaced to the left.

Craniotomy revealed an old chronic subdural hematoma and an intracerebral hemorrhage in the right frontal lobe, probably due to a ruptured anomalous vessel.

*Comment.* This case is an excellent example of the type of arteriovenous anomaly that may be confused with meningiomas or very vascular gliomas. The routine skull roentgenograms revealed erosion of the lateral margin of the sphenoidal ridge and enlarged emissary channels in the right frontal bone (Fig. 18). The base of the skull presented enlargement of the foramen ovale and the foramen lacerum with erosion of the intervening bone. All of these changes could have been produced by a meningioma.

The angiogram showed a large anomalous vessel in the region of the anterior cerebral artery which appeared to communicate with several superficial vessels, pos-

sibly superior cerebral or meningeal veins (Fig. 19). A few small "nests" of vessels were noted and there was a marked shift of the midline vessels to the left.

At first we thought the picture was that of a vascular meningioma that was deriving its blood supply from meningeal branches of the external carotid as well as the anterior cerebral artery. However, the capillary "stain" one might have expected with a meningioma was lacking. This proved to be an arteriovenous anomaly complicated by intracerebral and subdural hemorrhages secondary to rupture of one of the anterior cerebral vessels and one of the meningeal components similar to those described by Ray.<sup>61</sup>

CASE X (Fig. 20). (Previously reported by Govons and Grant; their Case v.)

The patient was a white male, aged twenty-three, admitted May 8, 1941, complaining of paralysis of the left side of the body. Frequent right frontal headaches had been present since April 23, 1941. On May 8, 1941, he began to have sudden severe dizzy spells with photophobia.

Physical examination revealed hyperesthesia over the right frontotemporal region, photophobia, paresis of the fifth and seventh cranial nerves, and left hemiplegia. The cerebrospinal fluid was xanthochromic.

Right-sided angiography revealed a large vascular lesion in the right temporoparietal region. Anomalous vessels were noted in a contrast study of the left hemisphere.

*Comment.* This angioma might have been confused with an unusually vascular glioma for no remarkably enlarged anomalous vessels were noted.

CASE XI (Fig. 21). The patient was a colored female, aged eighteen, admitted complaining of attacks of petit mal for fourteen years. She had had mild head trauma at six years of age and had noted burning in her eyes since the age of twelve.

Physical examination revealed the left pupil to be larger than the right, bilateral nystagmus on lateral gaze, blurring of the right optic disc, bilateral corneal opacities, and left central facial weakness. Electro-encephalography revealed a localized lesion in the right temporoparietal region. Routine skull roentgenograms showed

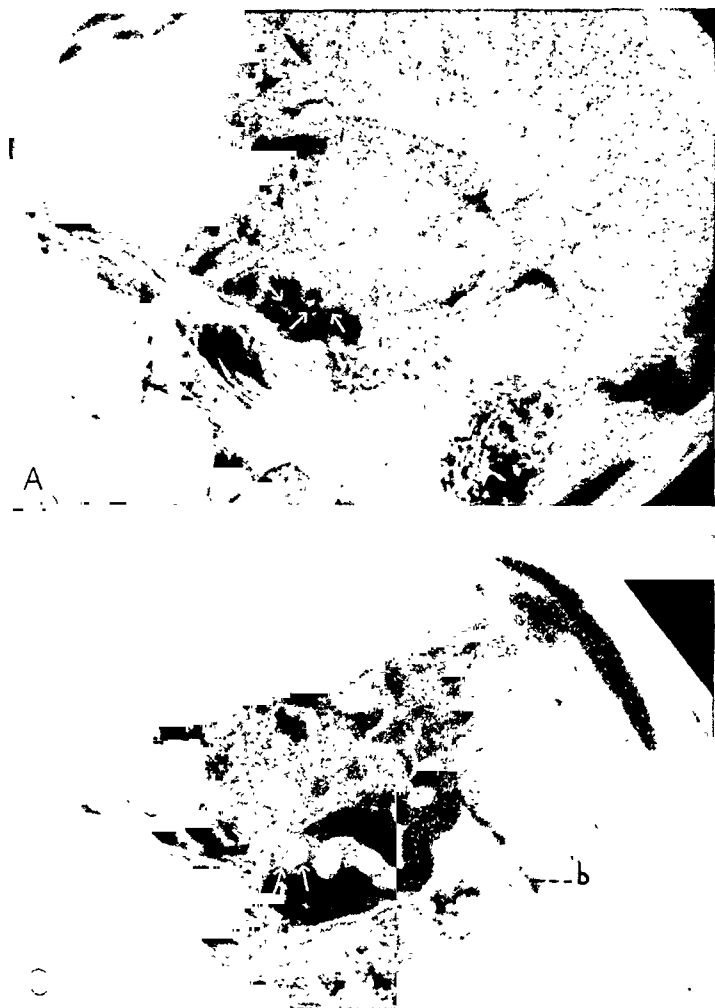


FIG. 21. Case XI. A colored girl, aged eighteen, with a large arteriovenous angioma in the right cerebral hemisphere. *A*, in the lateral encephalogram several large shadows (arrows) are visible in the cisternae interpeduncularis and chiasmatis. *B*, the posteroanterior encephalogram reveals no displacement or distortion of the lateral ventricles. *C*, the arteriogram reveals the shadows in the basal cisternae to be dilated blood vessels (arrows). A large "nest" of anastomosing vessels, *a*, and the straight sinus, *b*, are also well visualized.

bone erosion in the region of the right jugular foramen. Angiography revealed a large vascular lesion in the right frontoparietal region.

*Comment.* The routine encephalogram revealed no ventricular deformity or shift. Round shadows in the region of the cisternae chiasmatis and interpeduncularis were observed which, when compared with the arteriogram, were found to represent tortuous dilated vessels seen end on (Fig. 21). We have seen similar vessels projecting into the lateral ventricles.

CASE XII (Fig. 3 and 4). (Previously reported by Govons and Grant; their Case VI.)

A white man, aged twenty-three, complained of epileptiform seizures. For five years the patient had sensations of prickling and numbness, lasting about thirty seconds and occurring three to four times a week. These started in the right foot and spread upward to involve the entire right side. In June, 1940, after one of these sensory attacks, he suddenly became un-

conscious and had a right-sided convulsion. In the next one and a half years he had seventeen such clonic seizures. Recently clumsiness had been noted in the right hand.

Neurological examination on December 1, 1941, showed a normal gait, some impairment of the finer movements of the right hand, normal stereognosis and position sense, and some diminution of the protopathic forms of sensation. The tendon reflexes were slightly more active on the right side than on the left, and the strength of the right arm was slightly diminished. There was an old macular choroiditis with partial atrophy of the left optic nerve and weakness of the right side of the face of central type.

Routine skull roentgenograms revealed a small irregular calcification in the left temporal region. Localized thinning of the inner table was noted above the calcification. Numerous prominent diploic channels were present, most marked throughout the left calvarium.

In an encephalogram on December 9, 1941,

there was a slight shift of the ventricular system to the right.

An arteriogram showed an enlarged left carotid artery leading to an angiomatous mass in the temporoparietal region. The patient was referred for radiotherapy.

Operation on November 20, 1942, revealed a large arteriovenous anomaly in the left fronto-temporoparietal region (Fig. 4). The rolandic vein was so large and thin that blood could be seen swirling through it. There were also several large veins in the sylvian fissure. A slight bulge in this region suggested the possibility of a tumor. Further surgery was deemed inadvisable and only decompression was performed.

Despite operation there was slow progression of the patient's symptoms. An angiogram on January 4, 1945 was interpreted as showing extension of the lesion.

*Comment.* The routine skull roentgenograms revealed small granular calcifications in the left temporal area and erosion of the inner table. The encephalogram showed a slight shift of the ventricular system to the right (Fig. 3). Angiography revealed a large carotid artery and vascular "staining" due to a nest of tiny angiomatous vessels. The second angiogram showed the marked venous changes which were not suspected in our first examination but which were seen at operation (Fig. 4).

This study demonstrated the value of angiography in outlining the deeper portions of vascular lesions whose superficial branches alone are seen by the neurosurgeon.

Radiologists are often asked to treat cerebral tumors in individuals suspected of having angiomas because of the discovery of superficial vascular anomalies at operation. It seems reasonable therefore to advise cerebral angiography routinely in such patients before planning roentgen therapy.

#### *Mass Lesions Other Than Vascular.*

The role of angiography in the diagnosis of intracranial mass lesions is gradually being appreciated. Although it is usually used as a supplement to encephalography and ventriculography, there are neurosurgical centers where angiography is pre-

ferred to air in debilitated patients and in the presence of excessive increased intracranial pressure.

*General considerations.* It is axiomatic that the closer to major blood vessels tumors lie, the more susceptible they are to diagnosis and localization by angiography. Small lesions, strategically placed, may be much more easily delineated than larger masses within the ventricles or near the terminal filaments of the cerebral arteries. Size alone does not render a tumor amenable to diagnosis by angiography but rather its ability to spread and distort the vessels of the brain.

Benign encapsulated lesions, such as certain types of meningiomas which enlarge by expansion and compression rather than infiltration, are more likely to cause smooth and clean cut displacement of the cerebral arteries (Fig. 25). Displacement of superficial vessels away from the inner table of the skull is also characteristic of convexity meningiomas.<sup>41</sup> Gliomas are infrequently located superficially and are more likely to cause bizarre irregular types of displacement. If, in addition, new vessels appear either within or around the mass its demonstration may be still more striking.

Recognition of the vascular bed within the tumor merits special emphasis. Egas Moniz<sup>14</sup> described a vascular pattern (tumor stain) which he thought distinctive in meningiomas (Fig. 7). He and Lorenz,<sup>46</sup> studying the circulation in meningiomas demonstrated that the internal carotid artery, as well as the external carotid, participated in their blood supply. Although most of the external carotid branches to meningiomas are derived from the meningeal arteries, superficial temporal vessels occasionally reach the tumors by piercing the calvarium (Fig. 25). These external carotid branches are extremely important in differentiating meningiomas from other highly vascular growths. The newly formed blood vessels leaving the parent meningeal arteries are thread-like, well outlined, and ramify in orderly tree-like fashion. They are short and end abruptly in the usually well

demarcated capillary "stain" which characterizes the tumor and which may persist when all other evidence of contrast medium leaves the brain. Large, abnormal, often short veins may be demonstrated around the circumference of the capillary "stain," but similar vessels may also be seen with oligodendrogliomas and glioblastoma multiforme (Fig. 32).

In the case of glioblastoma multiforme, Lorenz<sup>46</sup> found roentgen evidence of tumor circulation in approximately one-half of

lar vascular patterns in oligodendrogliomas (Fig. 29 and 33). In contrast to meningiomas (Fig. 7), gliomas are less likely to exhibit easily identifiable, well formed nutrient vessels branching from the normal arteries.

Occasionally vessels in tumor bearing parts of the brain fail to be visualized (Fig. 26 and 27). In some instances this is the result of thrombosis but the lack of visualization may be attributable to local pressure effects produced by the tumor. This

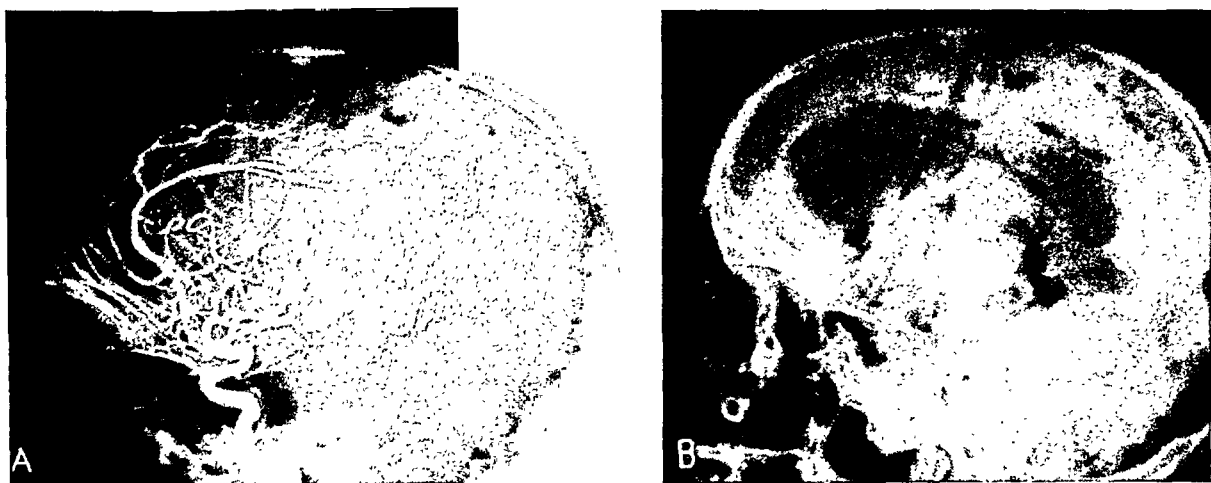


FIG. 22. A man, aged forty-six, with an obstructive internal hydrocephalus. *A*, in the arteriogram the normal curve of the anterior cerebral artery is accentuated. The course of the middle cerebral group is tortuous but not diagonal. *B*, the ventriculogram shows marked dilatation of the body of the lateral ventricle. The temporal horn is not sufficiently dilatated to produce a "diagonal middle cerebral group."

the cases. These he divided into three groups depending upon their roentgenographic appearance. In none of these were the blood vessels as maturely formed and regular as those seen in meningiomas. The first glioblastoma group was small and was characterized by a capillary stain within which delicate small vessels were observed. The second group, the largest, revealed numerous new and poorly formed blood vessels which formed an irregular network. Seen end on, the tiny new blood vessels looked like small pin points which were interspersed with occasional sinusoids or lacunae. The third group revealed rather large spiral-shaped masses of vessels through which veins could be seen during the arterial phase. We have observed simi-

may in some measure be overcome by increasing the injection pressure within safe limits. It is noteworthy that while mass lesions may cause incomplete or complete absence of filling of the vessels in the invaded half of the brain the contralateral normal hemisphere may reveal excessive filling.

Air studies are unquestionably far superior to angiography for the recognition of hydrocephalus. The evidence of the latter in angiography is usually indirect and only seen with difficulty. As a rule internal hydrocephalus accentuates the normal curve of the anterior cerebral artery without displacing it from its midline position (Fig. 22). With increased dilatation of the temporal horns of the lateral ventricles, the branches

of the middle cerebral artery become stretched and follow a diagonal course across the lateral aspect of the brain (Fig. 23). The parietotemporal branch of this group of vessels is particularly influenced in this manner. In excessively dilated lateral ventricles, the anterior horn may depress the first portion of the middle cerebral artery thereby accentuating its diagonal

of having space-taking lesions (Fig. 23, Case XIII).

CASE XIII (Fig. 23). The patient was a white boy, aged thirteen, complaining of right-sided convulsions for three years. Weakness of the right side of the body had been present since the age of five and one-half months.

Physical examination revealed right hemiparesis, hyperreflexia, and right homonymous

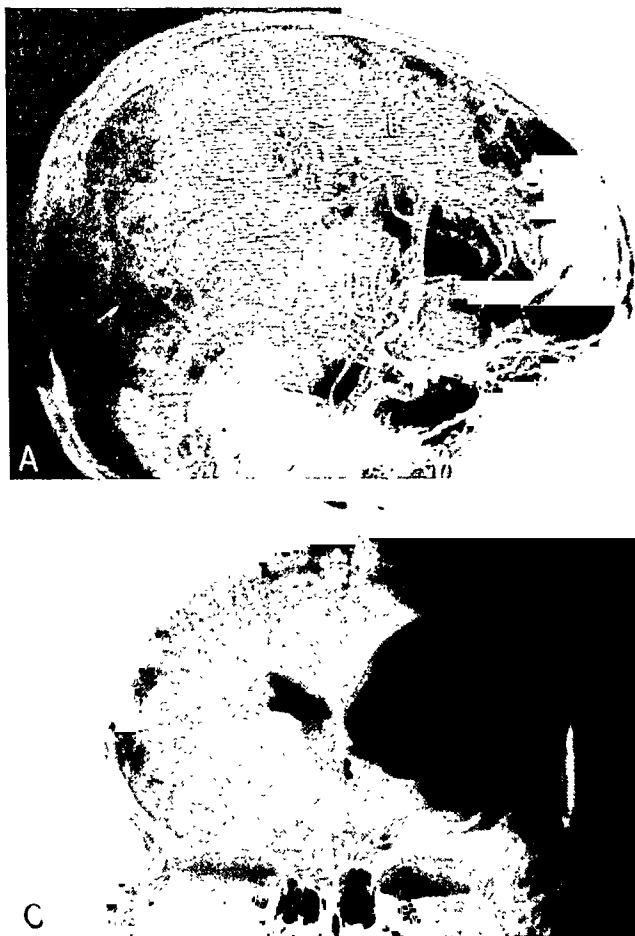


FIG. 23. Case XIII. A boy, aged thirteen, with porencephaly. *A*, in the arteriogram the distal portion of the reduplicated pericallosal artery, *a*, is displaced downward and the callosomarginal, *b*, is deviated upward. The course of the middle cerebral group, *c*, is diagonal. There is residual air in the ventricles from a previous encephalogram. *B*, the lateral encephalogram reveals extensive enlargement of the lateral ventricle. *C*, in the posteroanterior encephalogram the left ventricle is indistinguishable from the large porencephaly.

appearance. Cerebellopontine angle tumors, instead of depressing this portion of the middle cerebral artery, elevate it.<sup>9</sup> Thus when patients with angle tumors develop hydrocephalus they frequently fail to reveal the diagonal appearance of the middle cerebral group of vessels.

Porencephalic cysts, when large enough, will unquestionably be confused with cystic gliomas of the brain.<sup>58</sup> Their unilateral character and the fact that they often distort blood vessels make their recognition extremely important in patients suspected

hemianopsia. Electro-encephalography indicated a large cyst in the left hemisphere. A pneumoencephalogram showed advanced atrophy of the left cerebral hemisphere with enlargement of the lateral ventricle and porencephaly. Angiography showed bizarre displacement of the pericallosal artery.

*Comment.* Although porencephaly may occasionally be confused roentgenologically with cystic tumors, in this instance the hemiatrophy of the calvarium and the ipsilateral shift of the ventricular system were characteristic of porencephaly. The

bizarre tumor-like picture which may be produced in the arteriogram in these cases seemed worth recording. The arteriogram certainly suggests a high parietal mass lesion displacing the posterior portion of the pericallosal artery downward and

artery and to a lesser degree the middle cerebral vessels.

Strategically placed low lying frontal lobe tumors or very large lesions usually depress the superior portion of the carotid siphon tending to accentuate its normal

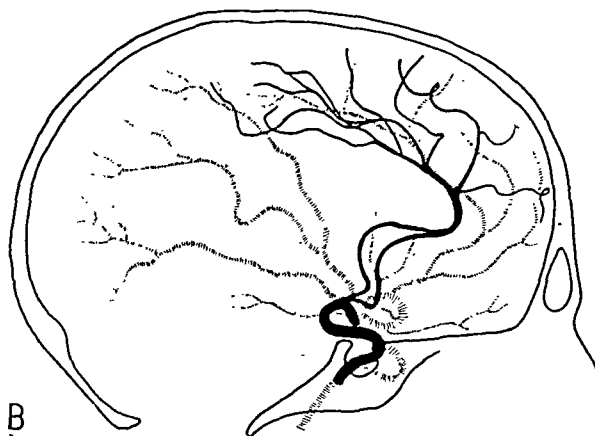
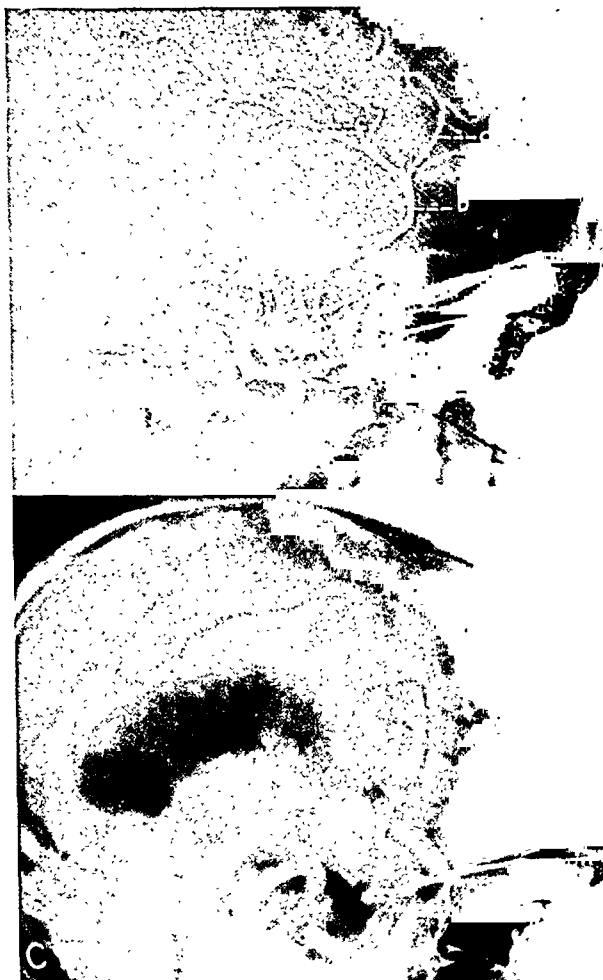


FIG. 24. Case XIV. A male, aged forty-two, with a mixed astrocytoma and astroblastoma in the left frontal lobe. *A* and *B*, the arteriogram and drawing show depression of the superior portion of the carotid siphon, *a*, slight depression of the anterior cerebral, *b*, and pericallosal, *c*, arteries, and anterior displacement or stretching of the callosomarginal artery, *d*. *C*, in the lateral encephalogram the anterior horn of the left lateral ventricle is depressed and there also appears to be involvement of the brain at the base of the anterior horn.

the callosomarginal upward. One might even explain the inverted "V" distortion of the pericallosal vessels on the basis of invasion of the corpus callosum. The diagonal course of the middle cerebral suggested marked ventricular enlargement. It is evident that the encephalogram was necessary for a satisfactory interpretation of the arteriogram.

*Frontal lobe region.* Space-taking lesions in the anterior fossa produce profound changes in the vascular tree. The vessels usually affected are the suprasellar portion of the carotid, the anterior cerebral

"S" shaped curve (Fig. 24, Case XIV). As they approach the midline these tumors tend to elevate the anterior cerebral artery and displace it posteriorly. The site of origin of the middle cerebral vessels may also be pushed slightly back and downward (Fig. 25, Case XV).

Representative of one group of anterior fossa tumors are the olfactory groove meningiomas. These usually displace the suprasellar and subcallosal segments of the anterior cerebral artery upwards and posteriorly. When large they compress the supraclinoid portion of the carotid and force



it backwards, tending to uncoil the "S" shaped curve of the siphon (Fig. 25, Case xv). Dott<sup>9</sup> has described a similar appearance in hypophyseal stalk tumors. Tumors lying higher, near the anterior tip of the frontal lobe, also displace the anterior cerebral artery posteriorly, but are in general less prone to distort its normal config-

group of vessels may also be deflected and assume a more horizontal course. When this occurs the frontoparietal artery is also displaced downward and posteriorly.

Displacement of the anterior cerebral artery as observed in the anteroposterior projection is probably more marked in mass lesions of the frontal lobe than in

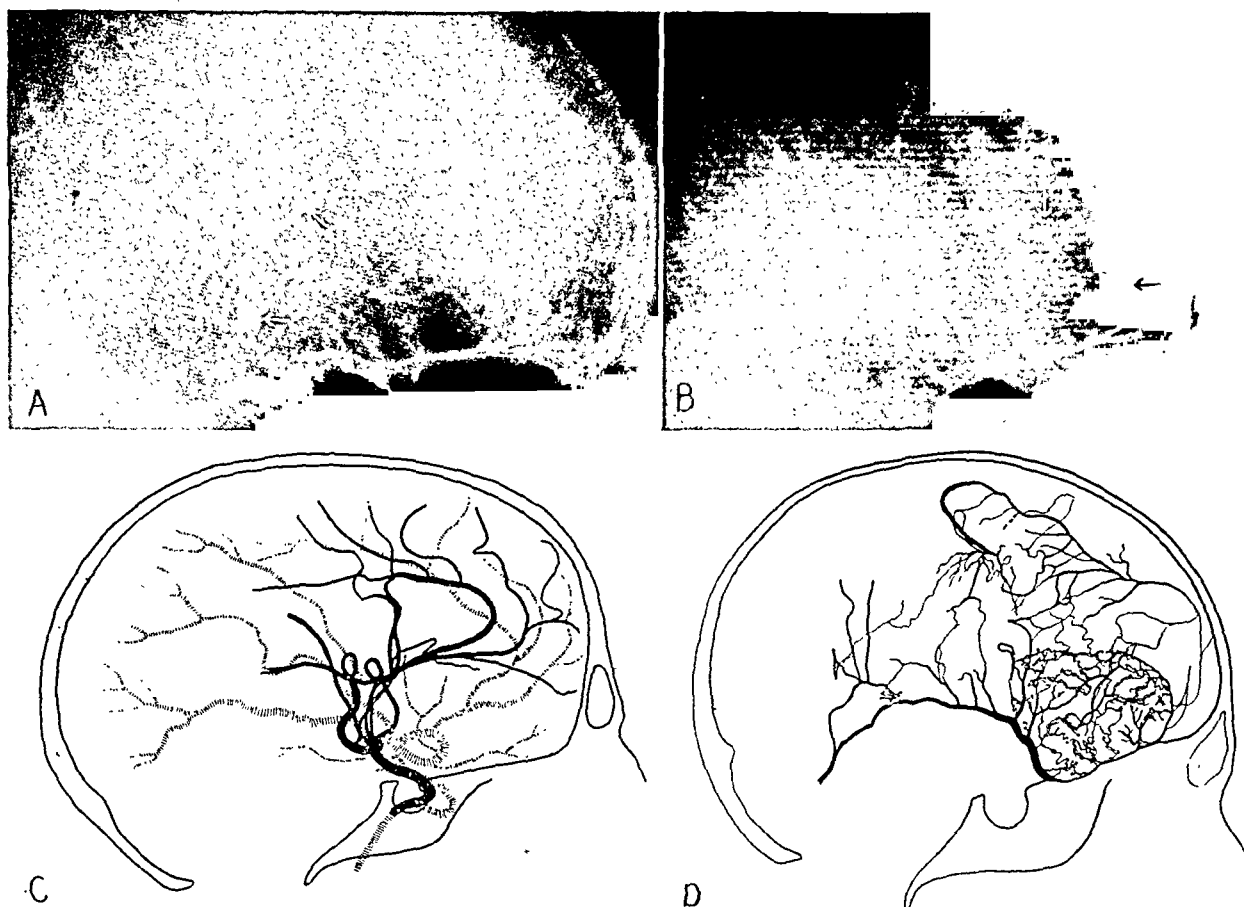


FIG. 25. Case xv. A man, aged forty-five, with a left olfactory groove meningioma. *A* and *C*, the arteriogram and drawing reveal marked posterior displacement of the anterior cerebral and carotid bifurcation (arrows). *B* and *D*, venogram and diagram showing a discretely outlined area (arrows) containing many tiny irregular vessels, the "tumor circulation." The middle meningeal vessel, *a*, supplying the tumor is well visualized.

uration. In addition the carotid siphon may be pushed backwards and downwards. In some instances it carries with it the site of origin of the middle cerebral artery (Fig. 25).

With high lying tumors in the premotor frontal region, the picture is still different. Here they tend to depress the pericallosal and callosomarginal branches of the anterior cerebral artery and compress the carotid bifurcation from above downward (Fig. 26, Case xvii). The middle cerebral

lesions elsewhere in the brain (Fig. 17). The importance of obtaining sagittal roentgenograms is therefore obvious.

CASE XIV (Fig. 24). The patient was a white male, aged forty-two, who complained of headache and mental confusion. Frontal headaches had been present for ten years. One year before admission he noted increased irritability and emotional instability. This was followed by the onset of suboccipital headaches. Two weeks before admission he suffered an attack of unconsciousness.

Physical examination revealed myopia, retinal degeneration and choroiditis, a fine tremor of the right extremities, and a positive left Babinski sign. Angiography showed a possible left frontal or suprasellar tumor. Ventriculography revealed a left frontal mass lesion.

A mixed protoplasmic astrocytoma and astroblastoma was partially removed from the left frontal lobe a few days after admission.

*Comment.* This case illustrates the ease with which certain large avascular frontal lesions may be missed by angiography. In instances such as this the venogram may provide the only clue to the diagnosis. The ventriculogram revealed a large left frontal lesion which was almost overlooked in the angiogram.

CASE XV (Fig. 25). The patient was a white male, aged forty-five, who complained of visual difficulties for three months. Two years before admission he had noted loss of smell. Recently dull headaches had occurred frequently.

Physical examination revealed papilledema and left hyperreflexia.

Routine skull roentgenograms demonstrated no localizing signs of an intracranial lesion.

Angiography showed evidence of a mass at the base of the left frontal lobe.

A craniotomy was performed and a left olfactory groove meningioma was partially removed.

*Comment.* This is an excellent example of a mass lesion at the base of the frontal lobe with posterior displacement of the anterior cerebral artery and combined compression and uncoiling of the carotid siphon. The tumor circulation, visible in the venogram, revealed a rather fuzzy group of irregular vessels which were not typical of meningiomas as described in the literature. However, several branches of the middle meningeal entered the tumor area suggesting the presence of such a lesion.

CASE XVI (Fig. 7). A male, aged thirty-five, complained of "epileptic spells" for one year. The attacks occurred at two week intervals and consisted of loss of consciousness with no convulsive movements other than twisting of the face. Severe frontal headaches and dimness of vision had been noted for three months. Three weeks before admission he began to have a

"thumping sound" in his right ear.

Physical examination revealed prominence of the right temporal region, mental dullness, bilateral papilledema, bilateral concentric contraction of the visual fields, hyperalgesia in the right temporal region, and a slight left facial weakness.

Routine skull roentgenograms showed enlargement and erosion of the sella turcica. An electro-encephalogram showed evidence of a right frontal lobe lesion. A right carotid angiogram outlined a large vascular tumor in the right frontoparietal region.

Operation revealed a large meningioma in the region of the right frontal motor cortex area and sylvian fissure.

Histopathologic diagnosis: Transitional angioblastic meningioma.

*Comment.* This angioblastic type of meningioma is a typical example of the "characteristic meningioma" as described by Egas Moniz. The angiographic appearance of meningiomas will vary according to their type of vascular pattern. This is evident upon comparison with Cases xv and xxi which were not angioblastic meningiomas.

CASE XVII (Fig. 26). The patient, a white male, aged forty-seven, complained of headaches for six weeks. The headaches were in the right temporoparietal region and were frequently followed by blurred vision in the upper outer quadrant of the left visual field. Impairment of smell and occasional diplopia were also noted.

Physical examination revealed a systolic precordial murmur, bilateral papilledema, slight divergence of the right eye, marked loss of smell, and bilateral decrease in hearing. Angiography revealed evidence of a right frontal mass lesion. Ventriculography showed a mass lesion in the left frontal region probably extending into the right hemisphere.

Left frontal craniotomy revealed a glioblastoma multiforme involving the tip and medial aspect of the left frontal lobe, probably extending into the corpus callosum.

*Comment.* This glioma was bilateral with greater involvement of the left frontal lobe. The right arteriogram did not show any tumor circulation because the main blood supply of the tumor was probably derived

from branches of the left carotid artery. The angiogram did show posterior displacement of the pericallosal artery suggesting involvement of the medial portion of the right frontal lobe. The findings in this case indicate the importance of doing bilateral angiographic studies in patients with mass

lesions which have infiltrated the corpus callosum will raise the pericallosal artery<sup>65</sup> (see Fig. 27). In addition the anterior cerebral may often be displaced but slightly in the sagittal plane because of the resistance of the falx. Notching of the vessel beneath the falx is occasionally<sup>7</sup> observed.<sup>41</sup>

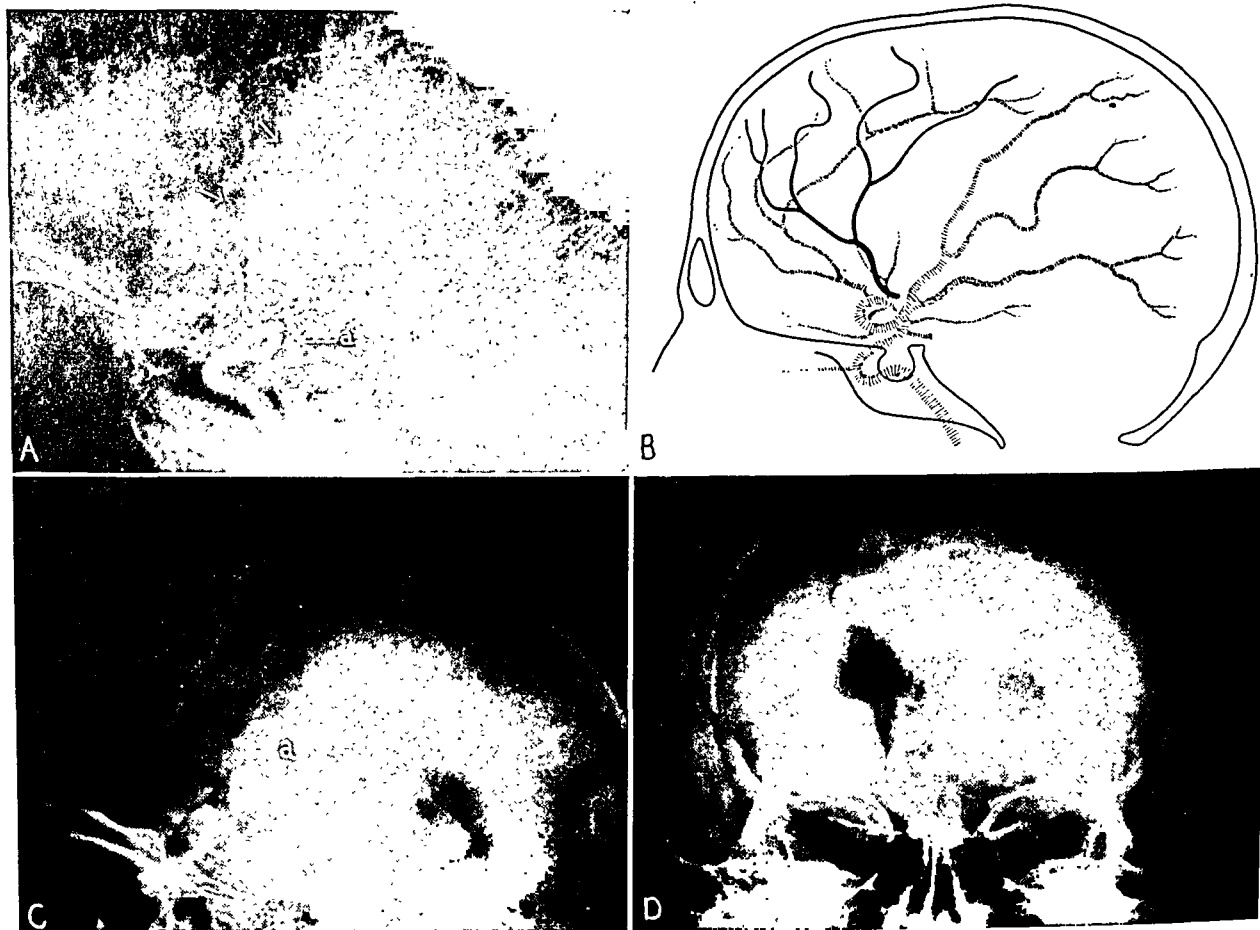


FIG. 26. Case XVII. A man, aged forty-seven, with a bilateral frontal glioblastoma multiforme. *A* and *B*, the right pericallosal artery (arrows) is displaced posteriorly and the distal portion is poorly filled probably because of compression by tumor invading the corpus callosum. Significant depression of the carotid bifurcation is present. Overlapping external carotid branches, *a*, are also filled. *C*, the lateral ventriculogram outlines a mass, *a*, projecting into the anterior horns and bodies of both lateral ventricles. *D*, the posteroanterior ventriculogram shows displacement of the ventricles to the right.

lesions, particularly when bilateral lesions are suspected.

*Parietal region.* Our experience with parietal lobe lesions has been limited. It is apparent that high lying parietal lobe lesions may depress and sometimes separate the pericallosal and callosomarginal arteries without causing much distortion of the middle cerebral group except in its terminal branches. Interhemispheric parietal

The findings in inferior parietal lobe lesions are well demonstrated in Figure 27. The middle cerebral group of vessels are often compressed and displaced downward and the terminal branches thus tend to come off at right angles (Fig. 28). Depending upon the size of the mass lesion, the anterior cerebral branches may or may not be displaced forward and upward.

Posterior parietal lobe lesions, particu-

larly those situated near the midline, may produce little vascular distortion. In such instances the appearance of the tumor circulation is of paramount importance (Fig. 28, Case XIX).

In the venogram the superior cerebral as well as the anastomotic veins of Labbé and Trolard may be affected by parietal tumors.

CASE XVIII (Fig. 27). The patient, a white male, aged fifty-nine, complained of headache

Angiography revealed evidence of a mass in the right frontoparietal region. At operation a glioblastoma multiforme was removed from the right frontoparietal region.

*Comment.* The tumor was relatively avascular. This was noticed at operation as well as by angiography. The avascular area between the anterior and middle cerebral groups identified the lesion in the frontoparietal region. The origin of the anterior cerebral artery appeared to be pushed down

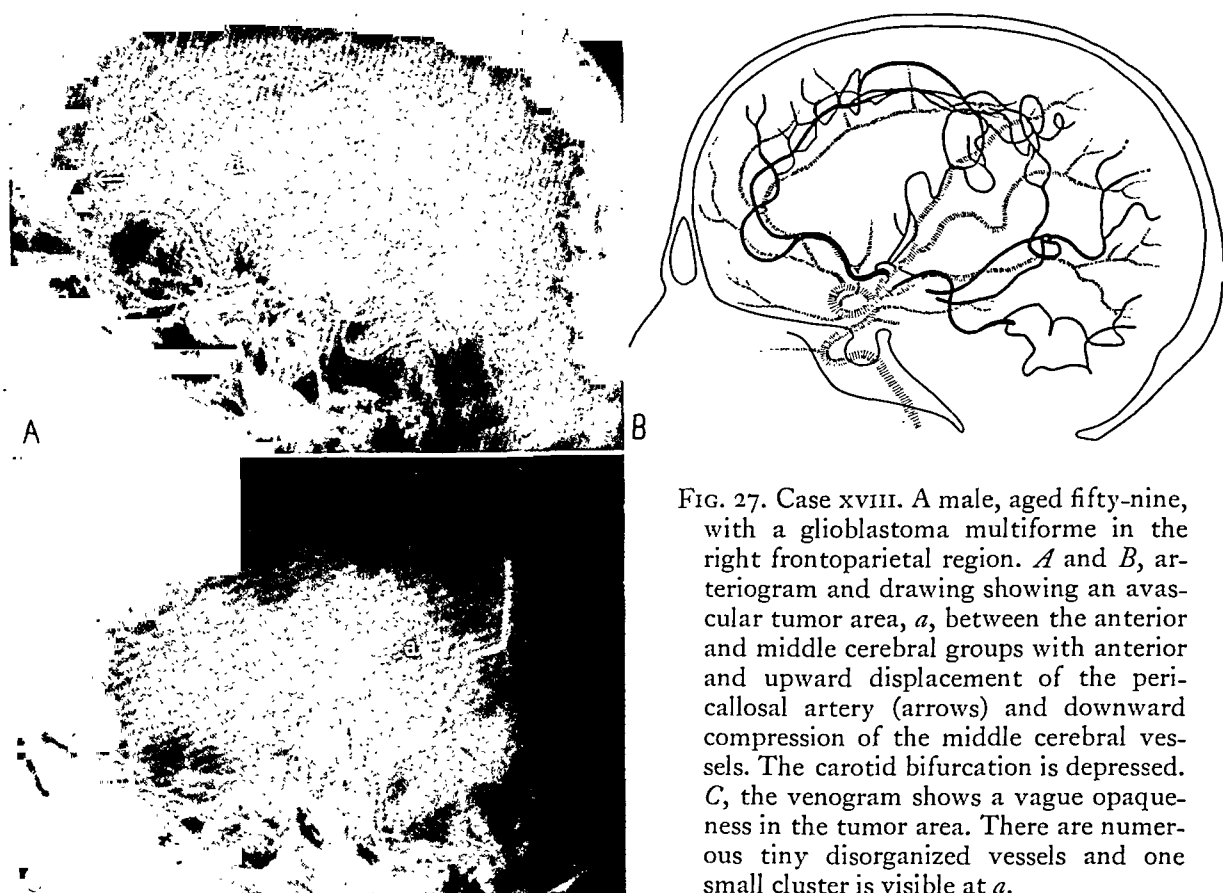


FIG. 27. Case XVIII. A male, aged fifty-nine, with a glioblastoma multiforme in the right frontoparietal region. *A* and *B*, arteriogram and drawing showing an avascular tumor area, *a*, between the anterior and middle cerebral groups with anterior and upward displacement of the pericallosal artery (arrows) and downward compression of the middle cerebral vessels. The carotid bifurcation is depressed. *C*, the venogram shows a vague opacity in the tumor area. There are numerous tiny disorganized vessels and one small cluster is visible at *a*.

and left-sided weakness. Three months before admission he suddenly lost consciousness for three hours but recovered within two days. Two months before admission he was seized with a convulsion which was followed by left facial weakness, frontal headache, weakness of the left side of the body and incontinence of urine.

Physical examination revealed neck rigidity, mental confusion, left hemiparesis, paralysis of the twelfth cranial nerve, and dilatation of the left pupil.

and the remainder of its course was distorted. The pericallosal branch was displaced anteriorly and its posterior portions were rather high suggesting the tumor invaded the corpus callosum and crossed the midline. A decrease in filling and downward displacement of the middle cerebral group was also observed.

CASE XIX (Fig. 28). The patient, a white male, aged fifty-four, complained of convulsive movements in the right arm for seven weeks.

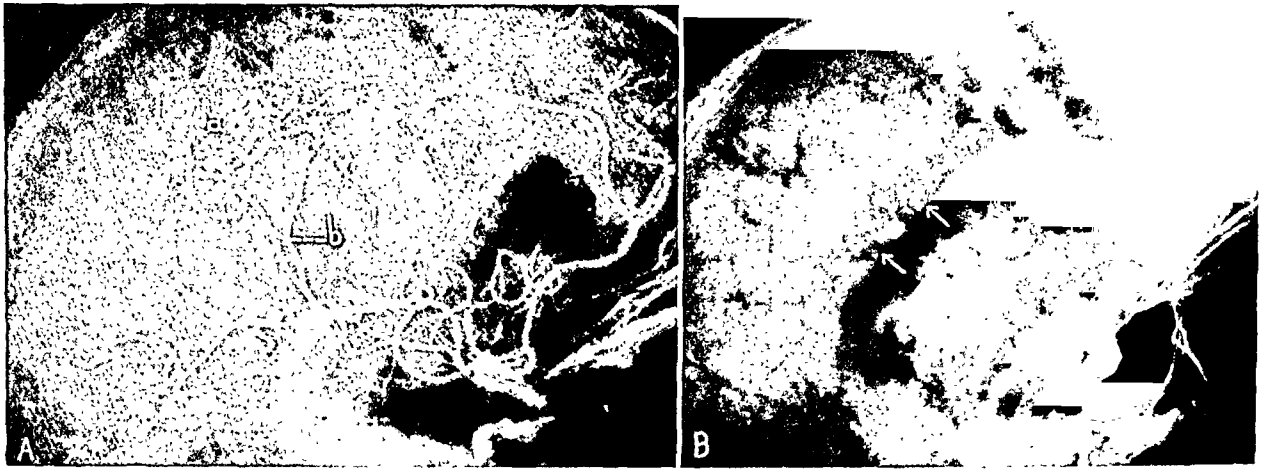


FIG. 28. Case XIX. A male, aged fifty-four, with metastatic adenocarcinoma in the left parietal lobe. *A*, a rather discrete highly vascularized area, *a*, is visualized in the parietal region. The middle cerebral vessels are displaced downward and many of the terminal branches, *b*, pursue a vertical course. *B*, the lateral encephalogram reveals a flat depression of the posterior portion of the lateral ventricle (arrows). The flat depression is characteristic of superficial mass lesions.

These attacks increased and spread until the face and right leg were involved. Loss of sense of position of the right arm had been noticed for three weeks.

Physical examination revealed astereognosis in the right arm, and a positive right Babinski.

Encephalography showed evidence of a large tumor in the left parietal region depressing the roof of the left lateral ventricle. Angiography revealed a vascular lesion in the left parietal region.

At operation a superficial encapsulated tumor 3 by 3 by 4 cm. was removed which proved to be a metastatic adenocarcinoma.

*Comment.* This metastatic adenocarcinoma contained innumerable tiny, irregular vessels. One must remember that the actual mass of the tumor may extend beyond its vascularized portion as demonstrated arteriographically.

*Temporal lobe.* Of the brain tumors localized by angiography, those in the temporal lobe are the most easily recognized. In the lateral projection the middle cerebral arteries are characteristically displaced upwards but the anterior cerebral group is unaffected (Fig. 29). In the anteroposterior

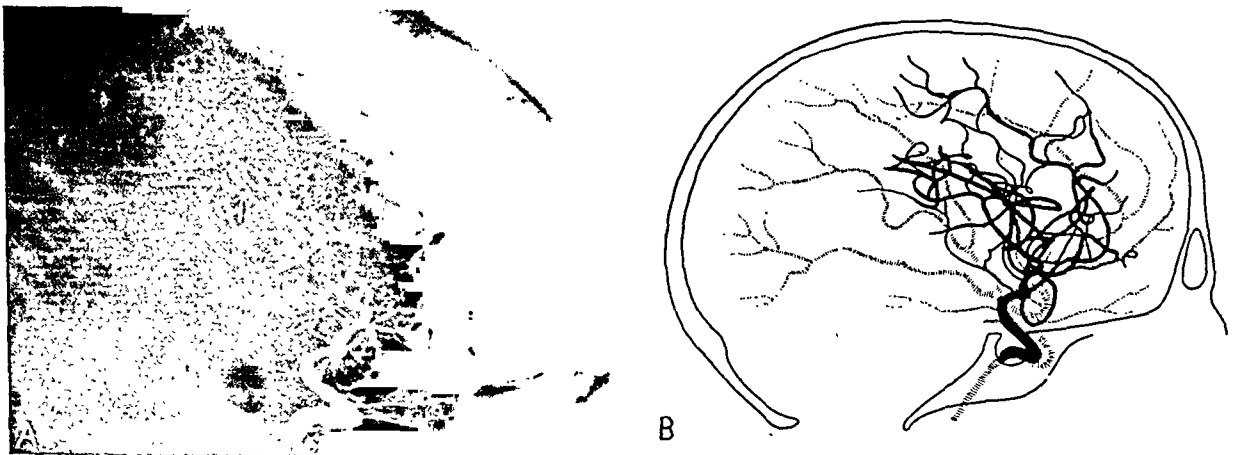


FIG. 29. Case XX. A man, aged forty-five, with an oligodendroglioma involving the left temporal lobe. The middle cerebral branches are displaced upward so extensively they are difficult to distinguish from the anterior cerebral group and the first portion of the middle cerebral artery is displaced anteriorly as well as upward (arrows). Numerous tiny abnormal vessels can be seen extending above and anterior to the temporal area.

projection the middle cerebral vessels are pushed medially, and the anterior cerebral arteries are not infrequently displaced across the midline (Fig. 30).

Tumors of the anterior portion of the temporal lobe, acoustic neuromas, and similarly located sphenoidal ridge meningiomas<sup>41</sup> involving the inner portion of the

of the carotid and the middle cerebral group upward and forward (Fig. 30).

The more posteriorly placed temporal lobe tumors are less prone to affect the carotid siphon, but may cause marked upward displacement of the posterior temporal artery or entire middle cerebral group.

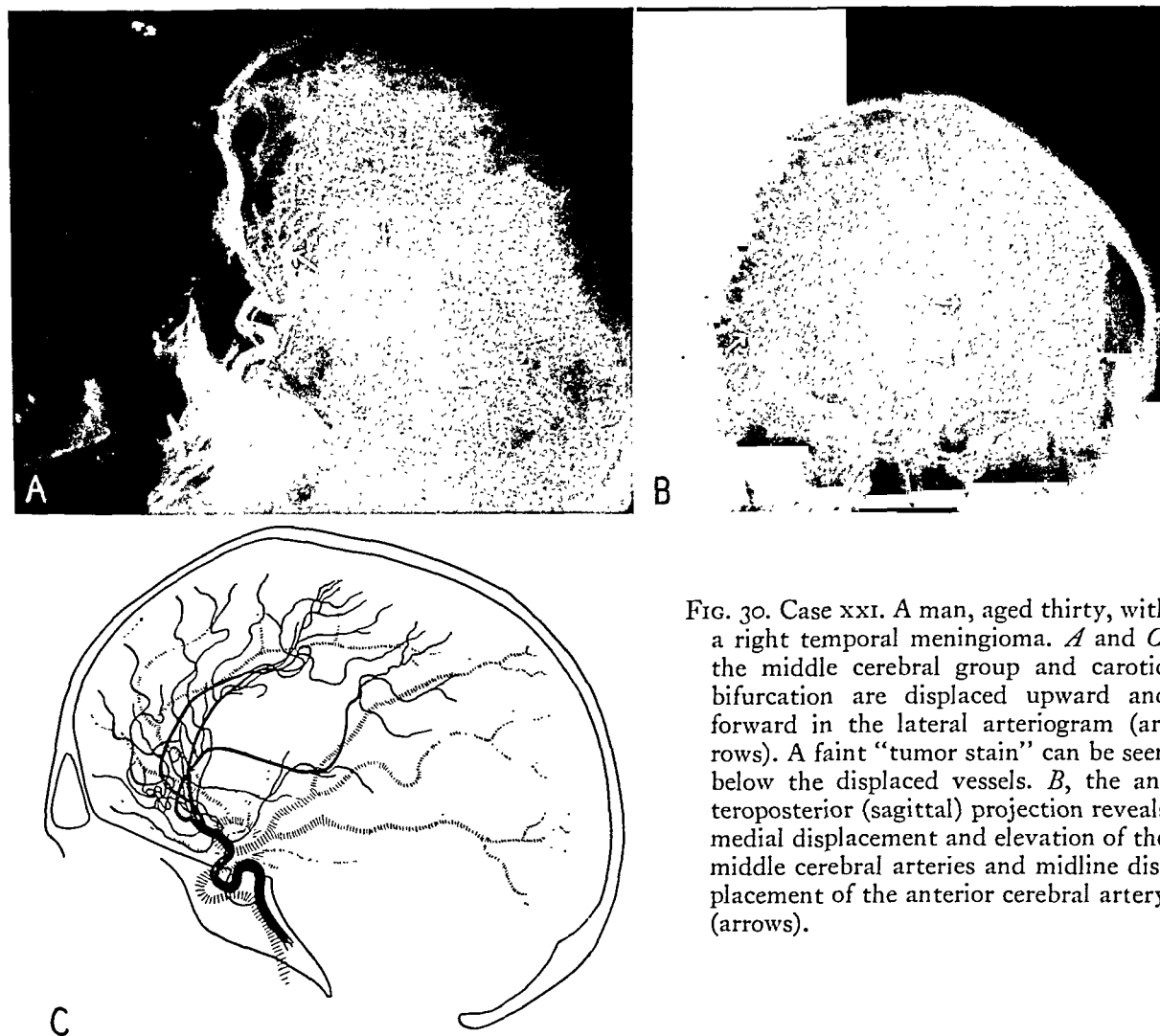


FIG. 30. Case XXI. A man, aged thirty, with a right temporal meningioma. *A* and *C*, the middle cerebral group and carotid bifurcation are displaced upward and forward in the lateral arteriogram (arrows). A faint "tumor stain" can be seen below the displaced vessels. *B*, the anteroposterior (sagittal) projection reveals medial displacement and elevation of the middle cerebral arteries and midline displacement of the anterior cerebral artery (arrows).

sphenoidal ridge may behave like large parasellar tumors, elevating the site of origin of the middle cerebral artery (Fig. 29). The first portion of the carotid siphon may be flattened and depressed (Fig. 31). Tumors occupying the more lateral portion of the sphenoidal ridge affect only the terminal portion of the carotid siphon, "uncoiling" it by pushing the supraclinoid segment

CASE XX (Fig. 29). The patient was a white male, aged forty-five, who complained of headache for five months. The headaches were occipital and had gradually increased in frequency and severity. Numbness of the right side of the body appeared three months before admission. This was followed by weakness in the right leg.

Physical examination revealed right hemiparesis, right central facial paralysis, papilledema, right hemianopsia, and motor aphasia.

Craniotomy revealed an oligodendroglioma involving the left temporal lobe.

*Comment.* The upward displacement of the middle cerebral group is characteristic of a temporal lobe lesion. However, the speckled lacework of tiny vessels, representing tumor vessels, extended high into the deep portion of the frontal and temporal lobes. This oligodendroglioma was not as vascular as Case xxiii (Fig. 32) but the tumor could be outlined vaguely by its capillary "stain" in the venogram.

CASE XXI (Fig. 30). The patient was a white male, aged thirty, admitted on December 12, 1947, complaining of headache and blurred vision for eight months. He had been admitted three years previously for back pain and weakness of the right leg. At that time a laminectomy revealed a neurofibroma in the thoracolumbar region. Following this the patient did well until eight months before admission when he began to have headaches accompanied by nausea, vomiting, and blurring of vision, more

on the left, with transient diplopia. There was a vague history of right-sided convulsions.

Physical examination revealed a slight left facial weakness, positive Romberg, adiadochokinesia of the left hand, diminished left corneal reflex and absent abdominal reflexes on the left side.

Routine skull roentgenograms showed only a persistent metopic suture. An arteriogram revealed evidence of a mass lesion in the anterior portion of the right temporal and inferior frontal region on the right.

A right frontotemporoparietal craniotomy revealed a well encapsulated tumor 5 by 5 by 6 cm. in the right temporal region. Dissection revealed that it projected into the inferior horn of the right ventricle.

Histopathological diagnosis: Meningioma, intraventricular, type II, 2, probably springing from the choroid plexus (called by Dandy fibroma of the choroid plexus).

The patient's postoperative course was uneventful and he was discharged improved.

*Comment.* This large intraventricular

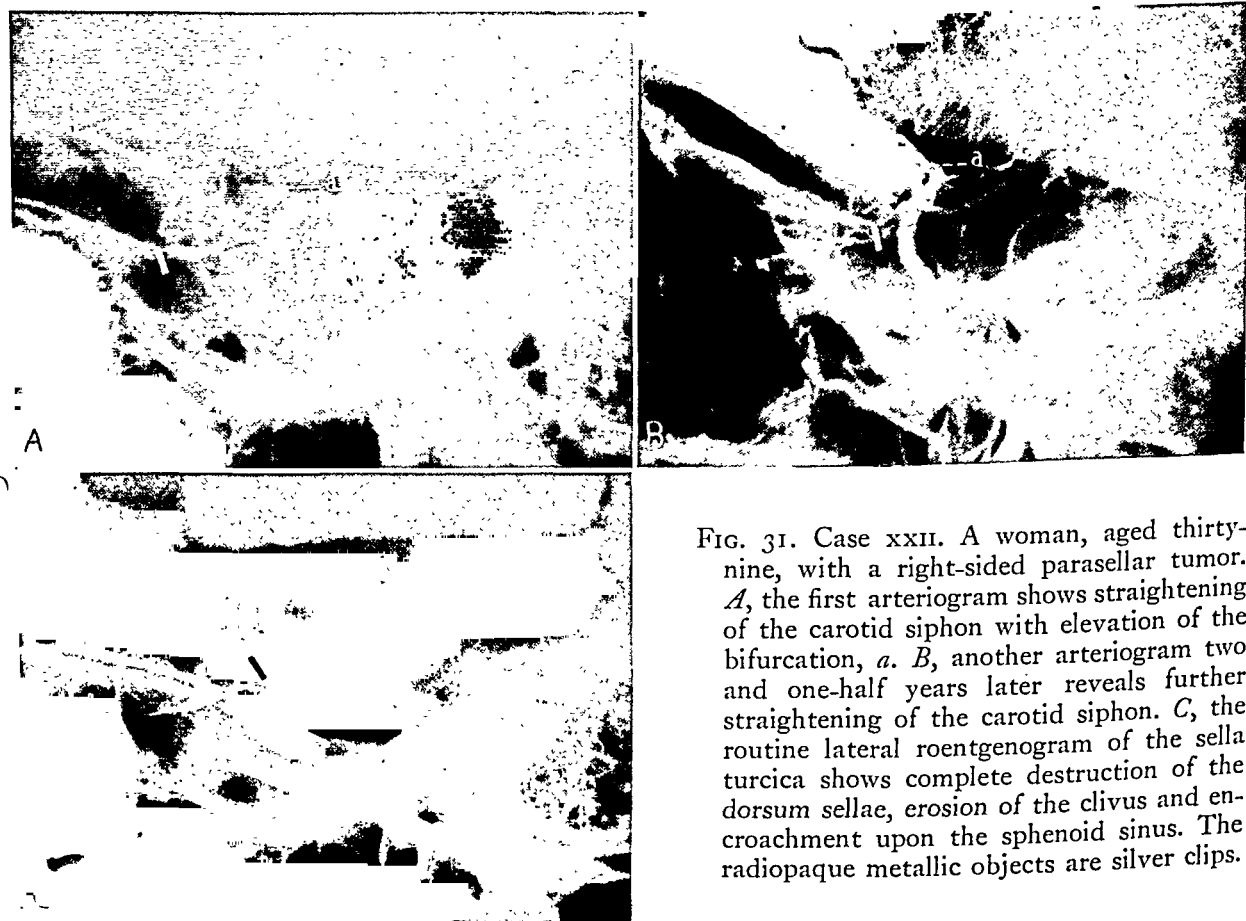


FIG. 31. Case xxii. A woman, aged thirty-nine, with a right-sided parasellar tumor. *A*, the first arteriogram shows straightening of the carotid siphon with elevation of the bifurcation, *a*. *B*, another arteriogram two and one-half years later reveals further straightening of the carotid siphon. *C*, the routine lateral roentgenogram of the sella turcica shows complete destruction of the dorsum sellae, erosion of the clivus and encroachment upon the sphenoid sinus. The radiopaque metallic objects are silver clips.

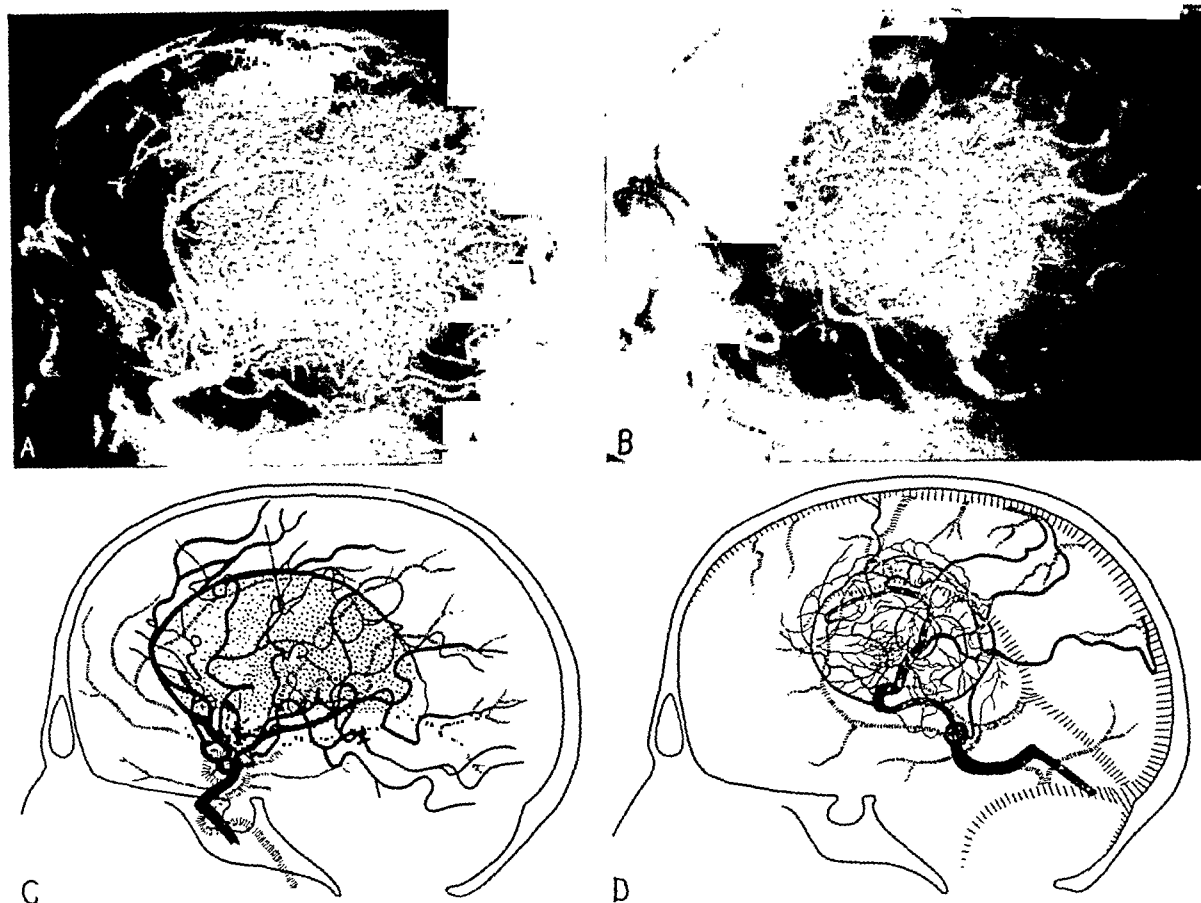


FIG. 32. Case xxiii. A man, aged twenty-six, with a midline oligodendroglioma. *A* and *C*, the arteriogram demonstrates upward and forward displacement of the anterior cerebral artery (arrows) with secondary straightening of the subcallosal portion. Networks of tiny vessels and a "stain" are visible in the tumor area. *B* and *D*, in the venogram many small vessels and a rather discrete "stain" visualize the tumor area. Small vessels outline the periphery of the tumor (arrows). The internal cerebral veins and adjacent venous sinuses are markedly distorted.

meningioma manifested little vascularity but caused marked upward and forward displacement of the supraclinoid portion of the internal carotid and the origin of the middle cerebral vessels. The displacement of the middle cerebral vessels is such that portions of them appear to overlap the course of the pericallosal artery.

*Occipital lobe.* We have had no experience with occipital lobe lesions. According to the literature lesions in this area may produce upward displacement of the terminal third of the middle cerebral group. Occasionally the pericallosal artery is elevated. Venograms may reveal displacement of the straight sinus<sup>14</sup> and ampulla of Galen or compression of the torcular Herophili and lateral sinus.<sup>65</sup>

*Midline tumors at the base of the brain and within the ventricles.* Parasellar tumors

usually "uncoil" the carotid siphon by flattening and depressing the inferior extradural portion of the carotid while at the same time elevating the superior portion of the carotid siphon (Fig. 31). In the anteroposterior projection there may be medial displacement of the carotid and its bifurcation. These tumors distort other portions of the vascular tree depending upon the area of the brain involved (Fig. 31, Case xxii).

Tumors originating in the sphenoid sinus will, of course, displace the carotid siphon posteriorly while suprasellar masses will displace the carotid bifurcation and first portion of the anterior cerebral artery posteriorly and upward in a manner similar to olfactory groove meningiomas. In the anteroposterior projection suprasellar tumors may, in contrast to parasellar lesions, displace the carotid bifurcation and proximal



anterior cerebral artery laterally.<sup>41</sup>

Midline masses posterior to the subcallosal portion of the anterior cerebral artery characteristically push the anterior cerebral vessels upward and forward, straightening the subcallosal portion of the artery and forming a concave arch which often outlines the periphery of the tumor (Fig. 32, Case xxiii). The course of the internal cerebral veins is usually markedly distorted. It is apparent that a large tumor may involve all of the areas described.

CASE xxii (Fig. 31). The patient was a white female, aged thirty-nine, admitted with the complaint of increasing lassitude. Six years

the most recent admission she noted increasing lassitude and a weight gain of 15 pounds. She also found that she was unusually chilly in cool weather.

Neurological examination revealed paralysis of the right third cranial nerve, diminished corneal sensitivity on the right, and personality changes evidenced by facetiousness. Visual fields showed a complete left homonymous hemianopsia. A second arteriogram was performed which again revealed distortion of the carotid siphon. Reoperation was refused.

*Comment.* Angiograms repeated at intervals may help evaluate changes in the size of intracranial tumors. This patient's first



FIG. 33, A and B. Case xxiii. Same case as Figure 32. The ventriculograms show the midline tumor, *a*, filling the third ventricle and extending into both enlarged lateral ventricles.

previously she had noted diplopia which was followed by signs of increased intracranial pressure. Five months later her menses stopped. One year later she was admitted to the hospital when it was noted that she had ptosis of her right eyelid as well as other signs of right third cranial nerve involvement. Routine skull roentgenograms showed an enlarged and eroded sella. The sphenoid sinus was dense and encroached upon.

An exploratory craniotomy revealed a possible extradural lesion in the region of the right cavernous sinus.

The patient was discharged slightly improved and later readmitted for an arteriogram which showed distortion of the carotid siphon. Extravasation of the thorotrast was noted during the procedure. Following this she noted no change for one and a half years. One year before

study revealed anterior displacement with straightening of the intracranial portion of the carotid due to a tumor which had eroded the hypophyseal fossa, clivus and sphenoid. The same examination repeated two and one-half years later showed still further elongation and straightening of the carotid siphon.

Of considerable interest was the extravasated thorotrast which first was observed after the initial injection and then again two and one-half years later. The extent of the radiopaque area remained unchanged in spite of the time interval between examinations.

CASE xxiii (Fig. 32 and 33). The patient was a white male, aged twenty-six, admitted com-

plaining of right frontal headaches for five months. He had also noted pressure in the back of his neck, poor vision, and roaring in the right ear. Vomiting had occurred two to three times weekly.

Physical examination revealed bilateral papilledema with secondary optic atrophy. The pupils were dilated and reacted sluggishly to light. Slight weakness was noted in the right leg.

Routine skull roentgenograms revealed en-

were displaced forward and up forming a rounded concavity which outlined the tumor. Numerous tiny faint blood vessels could be seen radiating into the tumor in a somewhat parallel manner similar to that occasionally noted in glioblastoma multiforme. The venogram was striking for it showed a well outlined delayed capillary stain which formed a background for a fine network of vessels. Small veins can be seen

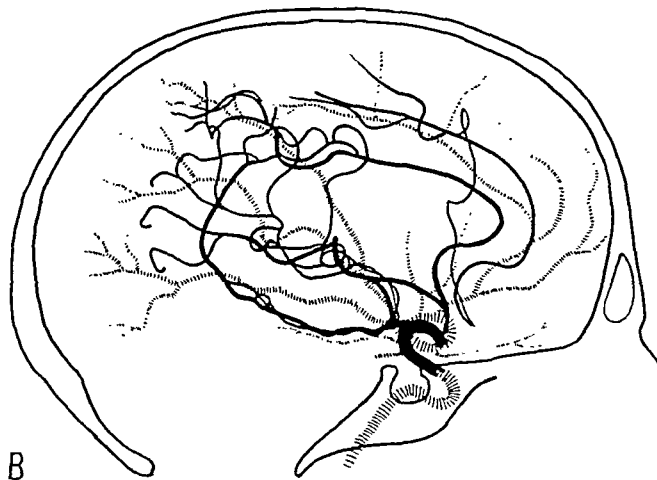


FIG. 34, *A* and *B*. Case xxiv. Arteriogram of a male, aged fifty-one, with an extensive mass lesion involving the left temporoparietal region and thalamus. The middle cerebral group is displaced downward and many tiny faint vessels representing tumor circulation can be seen extending above and below into the parietal and temporal regions. The anterior choroidal artery is displaced downward and posteriorly so that it appears to outline a mass (arrows). The terminal portions of the callosal arteries follow a sinuous course.

largement and demineralization of the sella turcica, with small calcific flecks in the right parietal region. An angiogram of the right side showed a large vascular lesion in the right parietal region. Ventriculography revealed a large midline lesion that projected into both lateral ventricles and the upper portion of the third ventricle.

Most of the tumor was removed through a right frontotemporal craniotomy and proved to be an oligodendroglioma.

*Comment.* The oligodendrogliomas we have studied thus far have been rather vascular and in some instances difficult to differentiate from meningiomas. These tumors, like the meningiomas, grow slowly and seem to have ample time to develop a "mature" circulation. In Case xxiii the anterior cerebral and pericallosal arteries

outlined the periphery of the tumor. Such vessels in the venogram are occasionally the only visible evidence of the presence of an avascular lesion. The venous system was distorted to such a degree that one might have been led to believe they were the anomalous vessels of a meningioma or angioma.

*Deep-seated tumors involving the thalamus and basal ganglia.* These lesions, though readily demonstrated by ventriculography, may be easily missed in angiographic studies. Fortunately the temporal lobe is often involved and changes are demonstrable in the middle cerebral group. Downward and posterior displacement of the anterior choroidal artery has been described as pathognomonic of thalamic tumors.<sup>41</sup> This vessel is frequently not visualized. We have

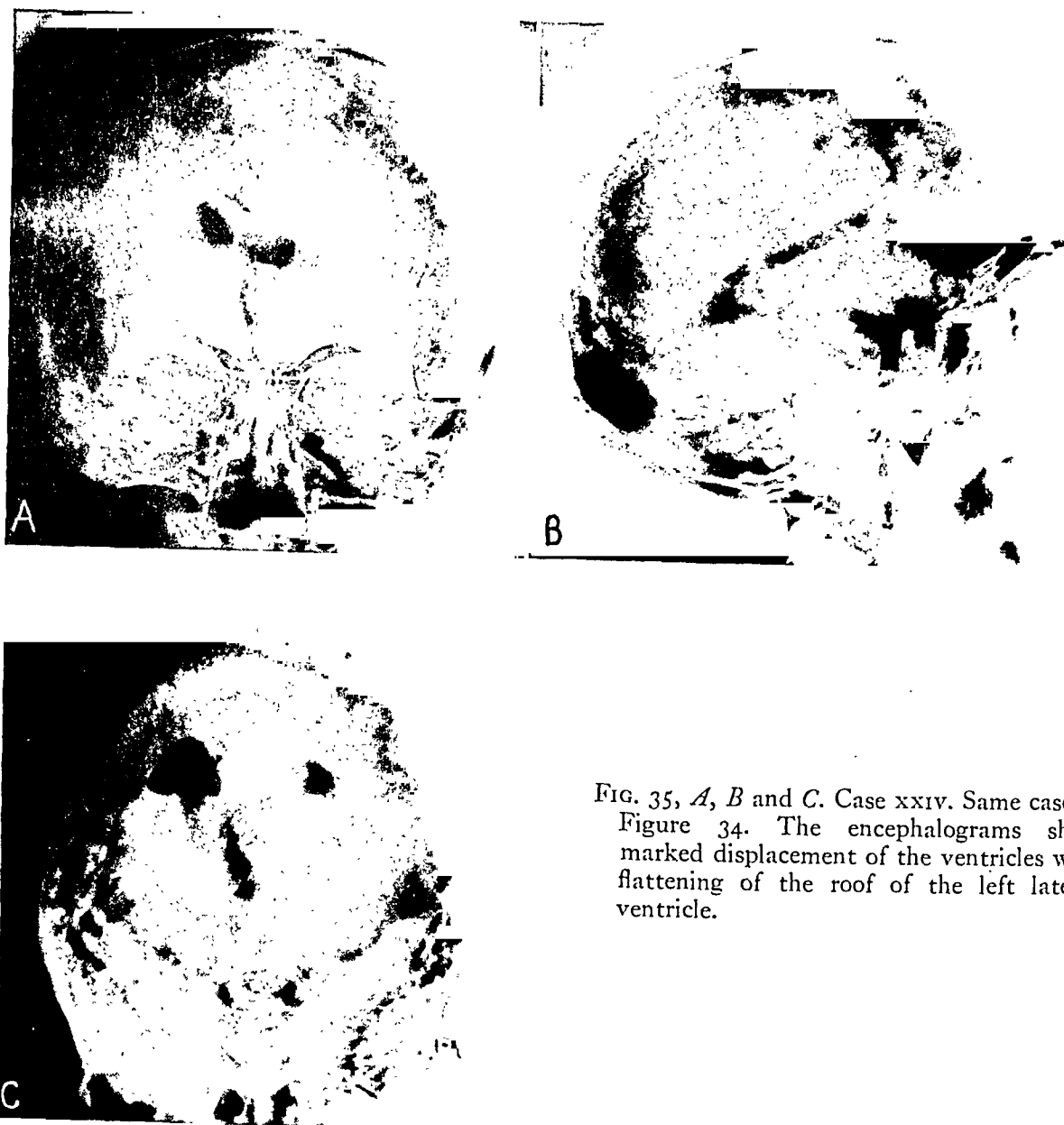


FIG. 35, *A*, *B* and *C*. Case xxiv. Same case as Figure 34. The encephalograms show marked displacement of the ventricles with flattening of the roof of the left lateral ventricle.

however, seen it characteristically displaced in a few instances (Fig. 34, Case xxiv). Lesions in this region may also grow upward in the midline causing anterior cerebral displacement similar to that described in Case xxiii (Fig. 32).

CASE XXIV (Fig. 34 and 35). The patient was a male, aged fifty-one, who complained of right-sided weakness and convulsions of five weeks' duration. Five weeks before admission he fell upon the ice and fractured several ribs. He did not lose consciousness but soon after noted increasing weakness in his right arm and leg. One week before admission he began to have right-sided convulsions which started in the right arm.

Physical examination revealed evidence of weight loss, loss of position sense on the right, right-sided agraphesthesia, a moderate mixed aphasia, a right hemiparesis which included the face, increased tendon reflexes in the right arm, absent abdominal reflex on the right, bilateral ankle clonus, and a positive right Babinski.

Routine skull roentgenograms revealed nothing abnormal. An angiogram demonstrated displacement of the anterior choroidal artery by a mass lesion involving the thalamus. An encephalogram showed displacement of the ventricular system to the right secondary to a temporoparietal mass lesion.

At operation a left frontotemporoparietal craniotomy revealed a yellow and muddy mass

in the temporal lobe. The lesion was not explored because of the patient's poor condition.

*Comment.* The identity of this tumor remains uncertain. The slight downward displacement of the middle cerebral group and the unusual course of the terminal portions of the callosal arteries, in addition to the displacement of the anterior choroidal artery, suggest an extensive single lesion or multiple lesions.

#### SUMMARY

1. The development of cerebral angiography is reviewed.

2. The advantages and disadvantages of various contrast media are summarized and the use of thorotrast is endorsed.

3. The indications and contraindications to cerebral angiography are outlined. The procedure is not advised during the acute phase of cerebral accidents.

4. A percutaneous method for injecting the carotid artery is described and its complications re-emphasized.

5. The normal cerebral angiogram and its many variants are reviewed.

6. Congenital, arteriosclerotic, and cavernous sinus arteriovenous aneurysms, their symptomatology, differentiation, and complications, are described. Illustrative cases are presented, stressing the angiographic recognition of hemorrhage into the sylvian fissure. Confusing variations in the appearance of cavernous sinus arteriosclerotic and arteriovenous aneurysms are illustrated and explained.

7. Occlusion of the carotid artery and its branches is frequently unsuspected clinically but may be readily diagnosed by means of cerebral angiography.

8. The clinical manifestations of arteriovenous angiomas are quite typical but variable. Routine skull roentgenograms and pneumoencephalograms may be of further aid in their diagnosis. Cerebral angiography allows demonstration of the type of lesion, i.e. simple or complex, and accurately localizes it for the surgeon or roentgen

therapist. Several cases are presented showing the various types of arteriovenous angiomas, some of which may be confused with vascular meningiomas and gliomas.

9. Unless extreme, enlargement of the lateral ventricles may be difficult to discern in cerebral angiograms.

10. The angiographic appearance of porocephaly is not diagnostic and may be confused with tumors as well as hydrocephalus.

13. Cerebral angiograms may in rare instances clearly demonstrate small vascular tumors not readily outlined by encephalography or ventriculography.

12. The displacement patterns of tumors in various portions of the brain are formulated and illustrated. Relatively large mass lesions may produce few changes if not strategically located in relation to the larger cerebral vessels. Accurate localization of such tumors requires an intimate knowledge of the normal vascular pattern and its variants.

13. Meningiomas produce angiographic patterns which may vary greatly depending upon the vascular bed of the tumor. Many derive their circulation from the internal as well as the external carotid arteries.

14. Oligodendrogliomas also exhibit varying angiographic patterns which are similar to those found in glioblastoma multiforme.

15. Metastatic adenocarcinoma of the brain may be unusually vascular and readily demonstrable by cerebral angiography.

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#### DISCUSSION

DR. FRED J. HODGES, Ann Arbor, Michigan. From what you have seen this afternoon, it is apparent that the good old days are gone forever, that era when the radiologist, comfortably forgetting all he had learned in his freshman and sophomore years about neuro-anatomy, could examine skull films, talk about osseous changes that might or might not be visible and feel that he had discharged his full responsibility to medicine.

Dandy had a lot to do with the changes which have come about. The annoying contribution he made by introducing aerography forced us to review and relearn soft tissue anatomy within the skull. The work you have heard described this afternoon beginning with Egas Moniz in Europe and followed pretty extensively in Canada, then in this country, has opened still another field which forces radiologists to go back to their textbooks of neuro-anatomy. Although the task is difficult, the effort required is distinctly worth while.

My sole excuse for discussing this paper is my connection with Dr. Burge and Dr. List of the University of Michigan with whom I have had the good fortune to delve into this particular field. It is an extremely interesting phase of diagnostic roentgenology. The paper which has been written by the gentlemen from Philadelphia is an exceptionally good one, and it covers the "waterfront," so to speak, on the subject of cerebral angiography. One cannot be connected with this work, even for a little while, without becoming enthusiastic over the diagnostic accuracy which can be achieved with the angiographic method. Obviously this is a specialized procedure which many in this audience will never have cause to use. It is interesting to all of us, however, to know that our branch of medicine has forged ahead to the point where we can detect and describe with extreme accuracy certain intracranial lesions which are invisible as a rule when other roentgen methods are used.

I would like to use several slides to illustrate a few important points in cerebral angiography.

(Slide) The first of these is similar to the first one that Dr. Perryman used, showing both lateral and anteroposterior projections after injection of the internal carotid in the case of a normal subject. These two views are supplementary and complementary. Without *both* of these projections no angiographic examination is complete. The anteroposterior view is extremely important. Unilateral space-occupying lesions will not displace the anterior cerebral artery which is situated in midline position in the anterior part of the cranial vault unless such lesions are located far anteriorly in the cerebrum. It should be noted that the entire cerebellar region is devoid of vascular shadows. This is true because except in about 15 per cent of individuals the subtentorial portions of the brain receive blood from the vertebral artery rather than the internal carotid.

(Slide) This second illustration will amplify what Dr. Perryman has said about vascular anomalies. It will be noted here that the internal carotid, after passing through the cavernous sinus, becomes very, very narrow just before breaking up into its major subdivisions. In contrast to the previous illustration, filling of cerebral vessels beyond the narrow point is scant. This is a striking example of carotid stenosis. Because of increased resistance to the injection of fluid at the point of stenosis, partial filling of the external carotid has occurred in spite of the usual efforts to prevent escape of opaque material into that branch of the vessel.

(Slide) A simple and commonplace vascular displacement produced by a temporoparietal tumor is shown in this next slide. Notice that the major branches of the middle cerebral artery, which should follow an almost horizontal course, have been elevated sharply.

(Slide) This is an example of "tumor stain," an expressive term which describes lingering opaque material in tiny vessels within the lesion where circulation time is slow. The vessels running into the tumor are distended with fluid, and the tumor itself is represented by a stain or a spot on the film. Large veins are to be seen creeping out to join the central vein. The lesion in this case happens to be a meningioma. The angiogram demonstrates the location as well as the extent of the tumor.

(Slide) In their original paper, Perryman, Chamberlain and Hodes point out that the radiologist has more than one string to his bow. Some tumors can be recognized by ordinary pre-

liminary or routine skull films. It has been our experience that this is true in a rather small percentage of all intracranial lesions. The use of encephalography or ventriculography greatly increases the scope and accuracy of intracranial diagnosis. Angiography is one more string to our bow which gives us an opportunity to see the vascular pattern of the brain, thus making new diagnostic signs available.

In the case of the patient here illustrated, however, the cerebral angiogram tells us little or nothing of value. On the other hand, the ventriculogram, representing an older technique, shows a sizable tumor. This is understandable because the opaquely filled vessels are peripheral to the location of the lesion in the thalamus and are not modified in appearance.

In closing, permit me to say that cerebral angiography is extremely advantageous and helpful as an adjunct to older methods in that particularized field of radiology which has to do

with localization of cerebral lesions. In that field, anything that will lead to accurate diagnosis is important. Used carefully, properly and selectively, cerebral angiography is an excellent agent of diagnosis.

DR. PERRYMAN (closing). Dr. Swenson has asked, "How many aneurysms have we missed because of incomplete filling?" To my knowledge we have missed none. Dr. Hodges has mentioned this in his paper and Dr. Swenson has had the same experience, so that it was a "leading" question, and it is apparently possible to miss aneurysms that have narrow necks or are thrombosed.

I would like to go a little further in advocating cerebral angiography and say that in certain instances it is not only of value in aiding in the localization of mass lesions but it may spare the patient the danger and discomfort of an air study.





# THE DIFFERENTIATION OF MEDIASTINAL TUMOR AND ANEURYSM BY ANGIOCARDIOGRAPHY\*

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THE differentiation of aneurysms from tumors which are close to the heart and/or great vessels is not always possible by conventional roentgen methods. The roentgen diagnosis of aneurysm ordinarily depends on the inability of the examiner to separate it from its vessel of origin during change in the position of the patient as well as by its active pulsation. Helpful also is the demonstration of disease elsewhere in the vessel. A tumor, on the other hand, characteristically does not pulsate, or, if pulsation is present, it is transmitted. However, it is well known that a thick-walled aneurysm may show no pulsation and that it may be difficult or impossible to distinguish transmitted from active pulsation.

Precise diagnosis is now of more than theoretic interest since treatment has become specific and often curative in this group of lesions. In the usual case, differentiation between tumor and a vascular structure can be made definitely by angiocardiology. An aneurysm ordinarily becomes opaque along with its vessel of origin. At the same time, other abnormalities in the vessel are demonstrated if present. A tumor does not fill with the opaque material. Its density remains the same throughout the examination. Adjacent vessels may be compressed or displaced but are not otherwise changed unless infiltrated by neoplasm in which case the outline is irregular or the vessel is occluded. On rare occasions, however, a fibrosing tumor may produce a traction aneurysm.

The angiocardiology procedure follows that described by Robb and Steinberg<sup>1</sup> with the addition of multiple exposures which are made at set intervals following the injection.<sup>2</sup> When the circulation is

judged to be normal, the aorta is well visualized within five to seven seconds after a rapid intravenous injection of 70 per cent diodrast solution. The injection is made through a large bore needle, either a No. 12 or 13 gauge for adults, and 40 to 50 cc. of solution is injected into an antecubital vein within one and one-half seconds. It is our custom when investigating the mediastinum to space five exposures at two, four, five, six, and seven seconds after injection. More recently, the exposures have been made in a predetermined phase of the cardiac cycle, the roentgen generator being energized from an electrocardiographic lead. The pulmonary artery, the aorta and the cardiac chambers are visualized regularly after a successful injection. This comment is made because occasionally there is a physiologic constriction in the subclavian vein as it enters the thorax which is sufficient to interfere with satisfactory injection. The reactions and contraindications to the procedure have been adequately discussed elsewhere.<sup>3</sup> Suffice it to say that the reactions usually are transient. Severe reactions have been rare and there have been no fatalities in over one thousand cases that have been examined. The procedure has been employed when there has been any question regarding differential diagnosis. Angiocardiology has been used routinely in instances of anterior mediastinal masses since it has been our experience that errors are most commonly made in this location.

A difficulty arises in the angiocardiology diagnosis of aneurysm when, because it is clotted or has a small neck, it fails to fill with diodrast. However, in this event, the aorta and/or pulmonary artery

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

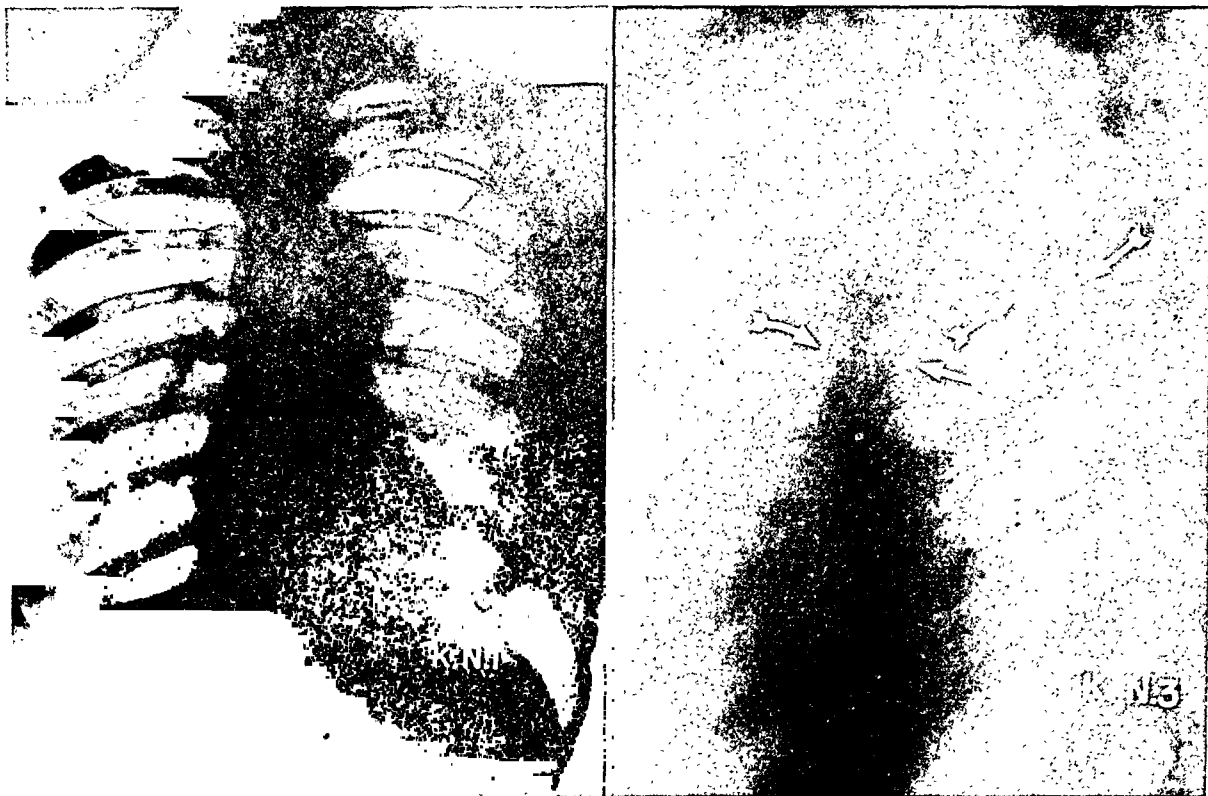


FIG. 1. Left anterior mediastinal tumor; dermoid cyst. Arrows point to aorta of normal caliber throughout.

may show dilatation or abnormalities in outline which will suggest the nature of the mass.

To illustrate the scope of angiocardiology in the study of mediastinal masses, the following cases are reported.

#### REPORT OF CASES

CASE I (Fig. 1) was a female, aged eighteen, whose only symptom was that of slight substernal pain. A left anterior mediastinal mass was discovered on roentgen examination of the chest. Roentgenoscopic examination by several

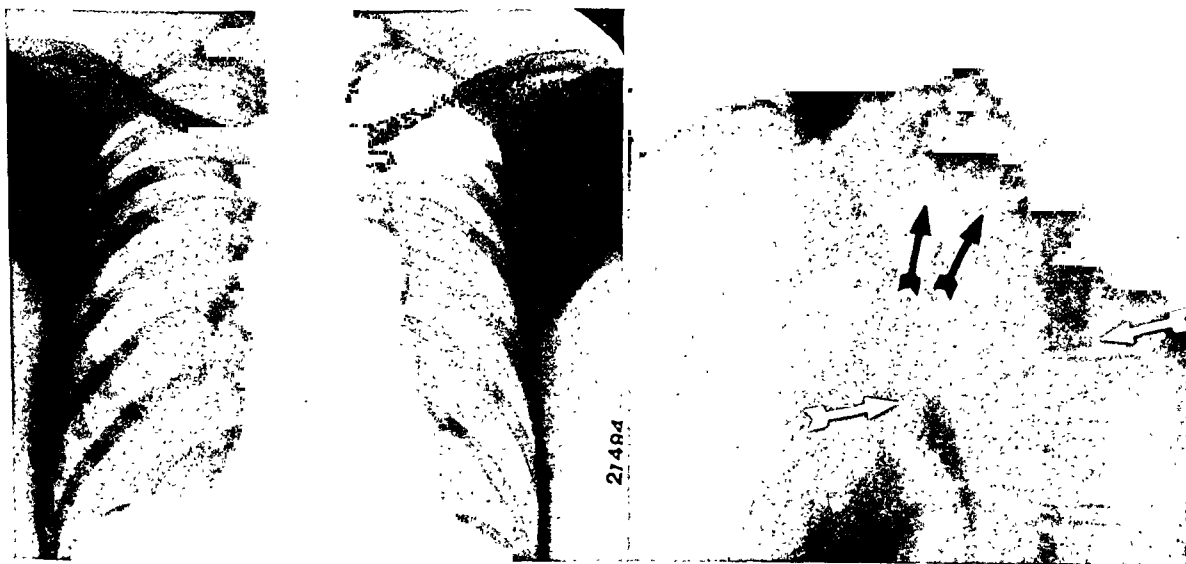


FIG. 2. Left posterior mediastinal mass; aneurysm of the descending aorta. White arrows point to aneurysm; black arrows to irregularities in the outline of the arch without dilatation.



FIG. 3. Post-stenotic dilatation of the aorta in a case of coarctation.

skilled roentgenologists and cardiologists at different institutions revealed what appeared to be active pulsations. Angiocardiographic examination disclosed a small but perfectly normal aorta and pulmonary artery. There were no irregularities in outline. The patient did not agree to operation for one year, at which time there was, in addition, a systolic murmur heard best over the mass. At operation, a dermoid cyst was found which was intimately adherent to the pulmonary artery. The tumor was suc-

cessfully removed. On examination the following day, the murmur had disappeared.

CASE II (Fig. 2) was a male, aged forty-five, in whom roentgen examination disclosed a left posterior mediastinal mass. By roentgenoscopy, it was difficult to decide whether pulsations were active or transmitted but the mass seemed to be continuous with the descending aorta. The clinical diagnosis was syphilitic aneurysm but there was no clinical or serological evidence of lues. Angiocardiography confirmed the clinical diagnosis of aneurysm of the descending aorta. However, elsewhere in the aorta there was no dilatation; on the contrary, particularly in the arch of the aorta, there were several constrictions. The nature of the aneurysm remains undetermined but the suggestion is made that it may be on a congenital basis. Irregularities in the aorta have been noted several times in connection with other congenital lesions of the cardiovascular system.<sup>4</sup> Post-stenotic aneurysmal dilatation in coarctation of the aorta, for example, is not infrequent (Fig. 3).

CASE III (Fig. 4) was a male, aged fifty. There was clinical and serologic evidence of lues. Roentgen examination of the chest revealed moderate enlargement of the left ventricle. The ascending aorta and arch appeared prominent. In addition, there was a small pulsating mass at the left hilum. Angiocardiography confirmed the presence of dilatation of the ascending aorta. The arch was of normal caliber; the prominence noted in the conventional roentgenogram was due to elongation. A marked



FIG. 4. Luetic dilatation of the pulmonary artery (white arrows) and moderate dilatation of the ascending aorta (black arrows).

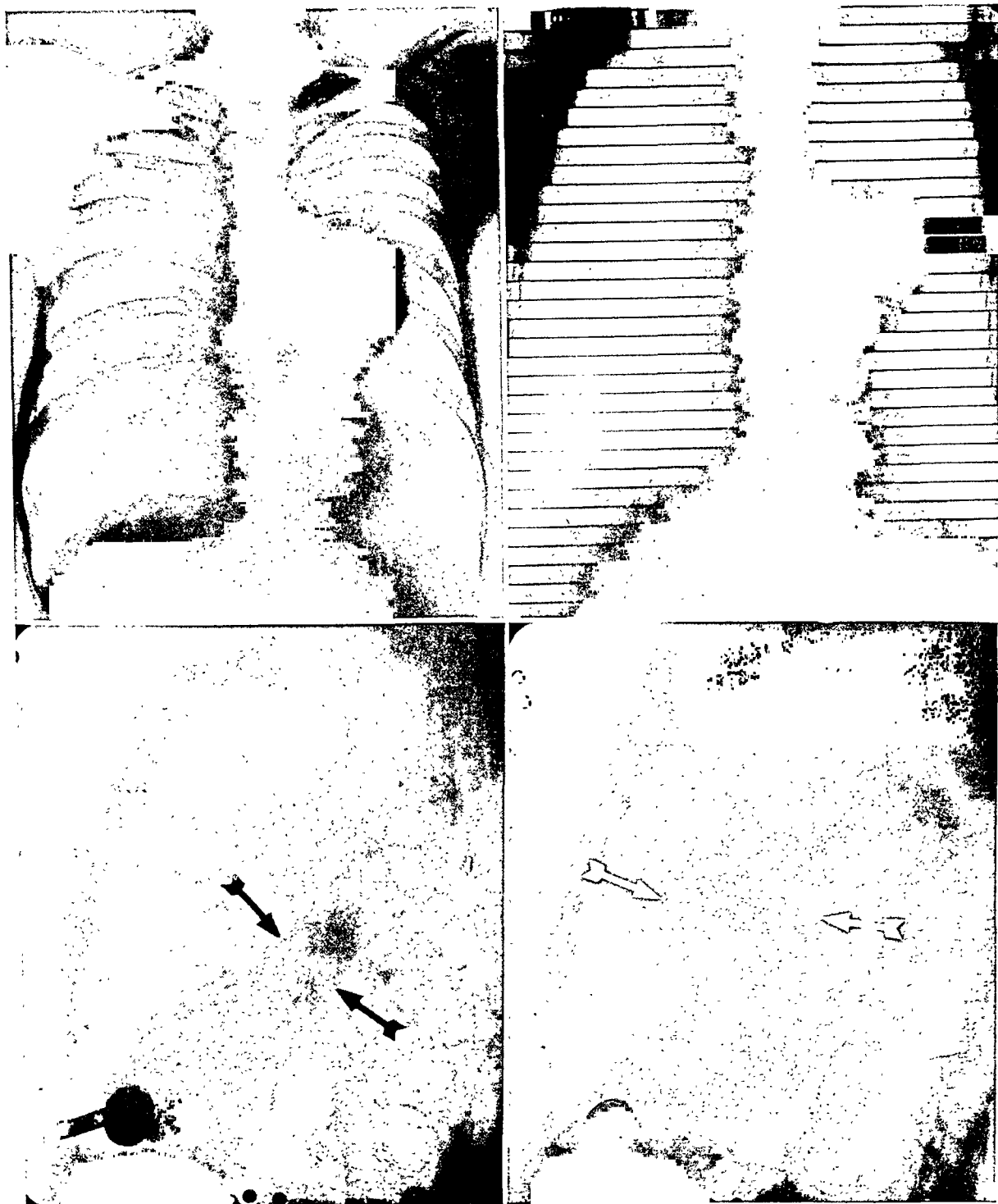


FIG. 5. Clotted aneurysm of the ascending aorta which did not fill with diodrast. Black arrows indicate displaced pulmonary artery. White arrows indicate irregularly dilated ascending aorta.

dilatation of the pulmonary artery was found which was quite unexpected and presumably also was due to lues.

CASE IV (Fig. 5) was a male, aged fifty, with clinical and serological evidence of lues. He

complained of a protruding pulsating mass to the left of the sternum, which had been present for more than ten years. Roentgen examination disclosed an anterior mediastinal mass which apparently was continuous with the external mass. No pulsations were present on roentgeno-



FIG. 6. Bilobed thymoma seen to left and right of the heart. White arrows indicate position of right auricular and right ventricular cavities. Black arrows indicate cavity of left ventricle. Peripheral arrows indicate the margins of the two tumors.

scopic examination nor could any be detected by roentgen kymography. The ascending aorta did not appear unduly prominent in the antero-posterior position. On rotation, it was difficult

to separate this structure from the mass. The arch, however, seemed distinctly dilated. Angiocardiographic examination showed the pulmonary artery of normal caliber but dis-

placed posteriorly and caudad. The ascending aorta was markedly and irregularly dilated and the dilatation extended into the arch. The mass, however, showed no change in density throughout the examination. The reason for this was apparent at postmortem examination when the mass was found to be a clotted aneurysm. Although, strictly speaking, angiocardiology had failed to provide a definite differential diagnosis of the mass, the presence of marked dilatation of the ascending aorta established the likelihood that it was a clotted aneurysm. A small neck also may prevent the entrance of sufficient diodrast to establish the diagnosis. It is for this reason that the procedure fails to establish the diagnosis of dissecting aneurysm.<sup>5</sup>

CASE v (Fig. 6) was a female, aged about thirty. The roentgen appearance of her chest is best visualized by inspection of the accompanying illustration. Angiocardiology was here indispensable. The superior vena cava, the right auricle and the right ventricle were clearly well within the right border of the central shadow. A right anterior mediastinal mass was therefore postulated and it was thought that the heart was displaced by it to the left. However, the left ventricular cavity, also, was well within the left border of the mass. A satisfactory explanation for this was not evident. The patient was subjected to surgical exploration through a right parasternal approach and a large anterior mediastinal mass was removed which on histopathological examination proved to be thymoma. This, however, did not explain the left-sided findings. Although postoperatively the patient was asymptomatic, angiocardiology was repeated. This confirmed the previous impression that there was a left parapericardial mass. The patient was therefore operated upon again and a large thymoma presumably arising from the left lobe of the thymus was removed. The final roentgenogram of the chest is also included in the illustration.

The clinical details of this case will be published elsewhere. For the present purpose it is sufficient to indicate how essential angiocardiology may be in the elucidation of mediastinal masses.

#### SUMMARY

Angiocardiological visualization of the heart and great vessels is an important aid in the elucidation of mediastinal masses.

Aneurysms ordinarily fill with diodrast along with their vessels of origin. At the same time, other abnormalities in the thoracic vascular structures may be demonstrated. The demonstration fails only when the aneurysm is clotted or when there is a small neck. By contrast, tumors do not impair the integrity of the large vessels except by compression and displacement. An exception is provided by malignant infiltration which may irregularly constrict or even occlude a large vessel.

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#### DISCUSSION

DR. MERRILL C. SOSMAN, Boston, Mass. This paper is very interesting and well illustrated, and it is another concrete contribution to greater accuracy in diagnosis. It fits in particularly well with the first paper because of the similarity of methods employed and because of the increased accuracy, although the methods described are really limited to that small percentage of cases where such particular methods are necessary.

Certainly the majority of aneurysms of the aorta are recognizable by conventional methods, but we all should stress the fact that the textbooks are erroneous in stating that the dif-

ferential diagnosis is easy because aneurysms pulsate and tumors do not pulsate.

In my experience, the majority of the large aneurysms of the aorta do not pulsate, whereas some tumors show the most beautiful expansile pulsation. These pulsating tumors have usually turned out to be thin-walled cystic tumors where the pulsation, of course, was transmitted because of its close proximity to the aorta.

The differential diagnosis in the latter group of cases that Dr. Sussman showed has become

particularly important because of the newer accessibility of the mediastinum to the surgeon. Formerly it was of very little importance to make a differential diagnosis because all that could be done was to treat the mediastinal tumor with roentgen irradiation if it were a tumor and there was nothing that could be done if it were an aneurysm. Now it is quite important to make that decision because so many of those mediastinal tumors can be successfully removed by competent thoracic surgeons.



# ABDOMINAL ARTERIOGRAPHY\*

## TECHNIQUE AND DIAGNOSTIC APPLICATION

By FREDERICK B. WAGNER, JR., M.D., ALISON H. PRICE, M.D., and  
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ALTHOUGH arteriography of peripheral vessels is now regarded as an established procedure, attempts at visualization of the abdominal aorta and its branches with radiopaque media are seldom made even in the large clinics. This may be largely due to the fact that the techniques described seem complicated and hazardous, and that the indications are not clearly defined. It is the purpose of this paper to describe a simple technique, employed without untoward sequelae in 26 consecutive instances, and to indicate its value as a diagnostic adjunct.

### TECHNIQUE

I. *Preparation of Patient.* A cleansing enema is administered to the patient in the morning and food is withheld. Morphine and atropine preanesthetic medication is given hypodermically three-quarters of an hour before the procedure.

II. *Actual Procedure.* Teamwork of a roentgenologist, two anesthetists, and a surgeon is required (Fig. 1).

#### A. Duties of Roentgenologist.

Exposure Factors. The target-film distance used is 30 inches. According to the thickness of the patient, 70 to 85 kilovolts are employed and 200 milliamperes. The exposure time is one-fourth of a second using a high speed Potter-Bucky diaphragm and par speed screens, fast film.

Preliminary Roentgenogram. The patient, on arrival in the roentgenographic room, is placed on the table in the prone position. A preliminary roentgenogram is taken in order to check for proper cleansing

of the colon, inclusion of the desired anatomic region, and correctness of the exposure factors.

Exposure of Aortogram. During the course of aortic injection, the arteriographic film is exposed at the exact moment designated by the surgeon.

#### B. Duties of Anesthetists.

When the preliminary roentgenogram has been approved by the roentgenologist or necessary corrections have been made, the patient is anesthetized lightly with 2.5 per cent pentothal sodium solution. A second anesthetist administers oxygen from a gas machine. One syringe containing 1 cc. of epinephrine solution (1:1,000) and another syringe containing 1.5 cc. of coramine are kept at hand for immediate injection if cardiac and respiratory stimulants are required. In our cases to date no need for their use has arisen.

#### C. Duties of Surgeon.

Equipment. A special aortic puncture needle with stilet, rubber tubing 2 feet in length with Luer-Lok adapters, and a 10 cc. Luer-Lok hand syringe are required (Fig. 2). The standard spinal puncture needle (11 cm. length) is too short for this procedure even in very thin patients. A No. 18 gauge needle at least 15 cm. long must be employed. We have used a malleable needle\* of the type recommended for continuous spinal anesthesia rather than the ordinary rigid type. It was felt that a malleable needle would probably cause less trauma to the pulsating aortic wall by

\* Obtained from Geo. P. Pilling and Son Co., Philadelphia, Pa.

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.



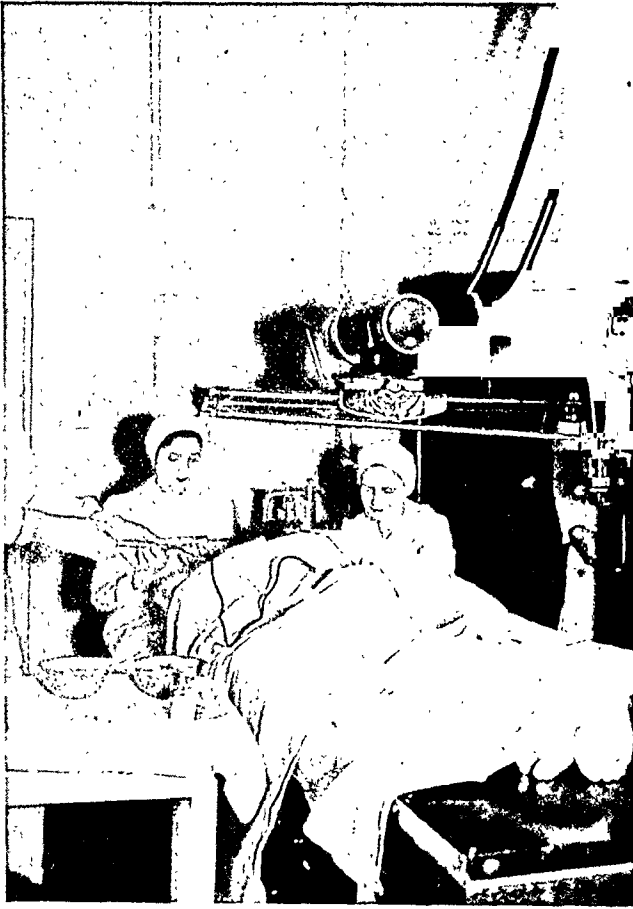


FIG. 1. Arteriography team in action.

moving with it more readily. Also, the added feature of an extra opening at the side of the needle near the tip decreases the resistance to injection. Aside from the special needle, the remainder of the equipment, including antiseptic solution, gauze squares, drapes, rubber gloves, and normal saline solution is available in any hospital.

**Radiopaque Medium.** An 80 per cent (wt.-vol.) solution of sodium iodide is freshly prepared the day preceding the procedure and sterilized. Striking arteriographic detail is produced following injection of 10 cc. of this solution in spite of its rapid dilution in the aortic stream. Organic iodides such as diodrast (70 per cent solution) have not proved as satisfactory for this purpose, since adequate aortic concentration requires more rapid injection than is possible through a long No. 18 gauge needle.

**Aortic Puncture.** After the patient has been anesthetized, the skin of the lower chest and back is prepared widely with antiseptic solution and draped. The classic

site for aortic puncture is at the level of the twelfth thoracic vertebra. The skin is pierced just below the left twelfth rib, four fingers' breadth from the spinous processes. The needle is directed anteriorly, medially, and cephalically toward the body of the twelfth thoracic vertebra until bone is encountered. The needle is then withdrawn 2 cm. and the point directed more laterally so as just to slip by the body of the vertebra (Fig. 3). The stilet is then removed and the needle cautiously advanced the remaining distance into the aortic lumen. The aorta is encountered as a resistance through which the needle snaps, imparting a sensation similar to that experienced when the dura mater is pierced during spinal puncture. A pulsating drip of bright red blood emerges from the needle in much less dramatic fashion than might be expected. Even in extremely hypertensive patients, although the flow is more rapid and the pulsation more vigorous, there is no actual spurting of blood. After the needle has entered the aortic lumen, it is advanced an additional 0.5 cm.

Arteriographic visualization of the celiac axis and its branches is usually best when aortic puncture is performed at the level

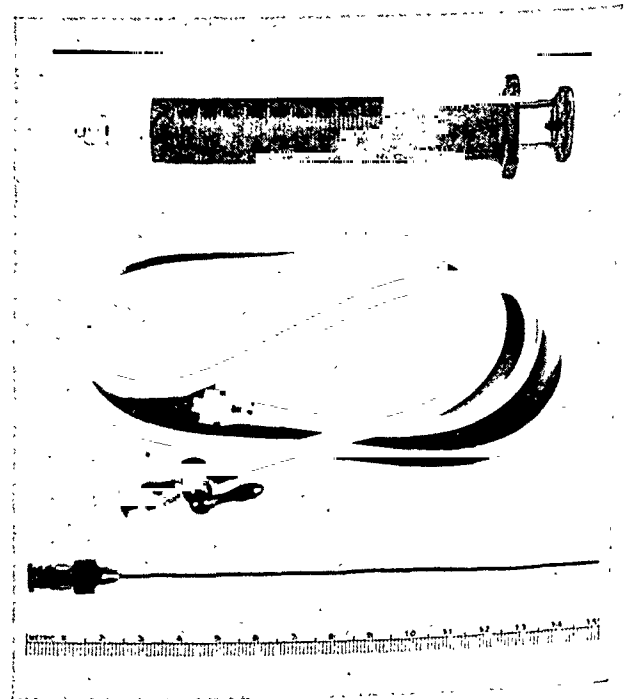


FIG. 2. Equipment for aortic injection.

of the twelfth thoracic vertebra as just described (Fig. 4). It has been our experience that visualization of the renal arteries is best when puncture is performed one vertebral level lower (Fig. 6). If the greatest interest centers about the lower part of the aorta or the iliac vessels and their branches, then puncture may be per-

aortic puncture, the needle is connected to the rubber tubing and syringe which have been previously filled with sterile saline solution. The Luer-Lok adapters should be maximally tightened. Alternate injection of saline solution and withdrawal of blood are performed in order to note the ease of flow in both directions and to assure the

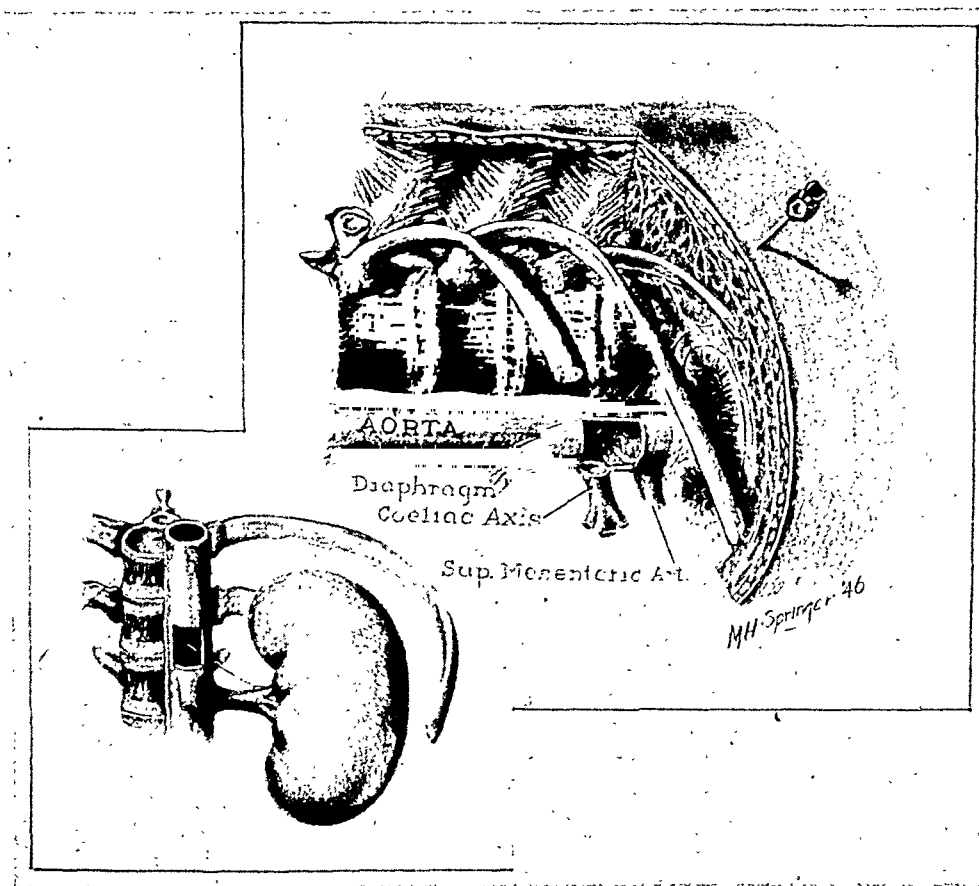


FIG. 3. Relational anatomy of aortic puncture. (Reproduced by permission from *J. Urol.*, 1946, 56, 625-635.)

formed at the level of the second or third lumbar vertebra (Fig. 7A). This allows greater concentration of radiopaque medium in these vessels, for at the higher levels a large portion of the iodide passes into the major visceral arteries (celiac axis, superior mesenteric, and renal). Puncture at these lower levels is more difficult because the aorta lies more anterior with respect to the vertebral bodies, and also because its size decreases. At these sites it is necessary to enter the skin six fingers' breadth from the spinous processes.

**Aortic Injection.** Following successful

operator that the needle is in the correct position. This precaution should obviate the possibility of extravasation of radiopaque medium during injection. Injection should never be carried out until this test has proved satisfactory.

In order to estimate the force required to inject the radiopaque medium within six seconds (2 cc. per second), a trial injection is made with 12 cc. of saline solution. This may be repeated as often as necessary. The stopcock is then closed and the syringe filled with approximately 12 cc. of the 80 per cent sodium iodide solution.



FIG. 4. B. H., aged twenty-seven. Blood pressure 180/120. Normal arteriogram, showing excellent visualization of celiac axis and its branches (puncture at level of twelfth thoracic vertebra).

Since the tubing retains about 2 cc., the total amount delivered to the aorta will be about 10 cc. Just before injection, blood is again withdrawn as final proof that the needle is well within the lumen. The signal "ready" is given to the roentgenologist at the moment injection is started (Fig. 1). As the final 1 or 2 cc. are leaving the syringe, the signal "shoot" is given. The needle is withdrawn immediately following exposure of the roentgen film.

III. *After-Care of Patient.* The patient's color, respirations, and pulse are carefully observed following injection of the iodide solution. As a rule the patient breathes more deeply, begins to move, and recovers from anesthesia within five to ten minutes. No untoward reactions have occurred thus far in our series. One liter of 5 per cent glucose in normal saline solution is administered through the needle left in place at the conclusion of intravenous anesthesia.

Administration of chloride ions hastens the excretion of iodide ions by the kidneys and aids in prevention of iodism. Iodism has not been observed in any of our cases. After two hours the patient is allowed his regular diet and walking is permitted if there are no other contraindications.

#### DIAGNOSTIC APPLICATION

1. *Aneurysm.* In some instances it is impossible on clinical grounds aided by the ordinary laboratory and roentgenologic studies to determine with certainty whether a pulsating abdominal mass is due to aneurysm or to tumor with transmitted pulsation. Figure 5 represents such a case in which an epigastric mass, proved by aortography to be a fusiform aneurysm, produced marked dysphagia. The patient, aged sixty-nine, had lost 30 pounds in weight. There was no roentgenologic evidence of erosion of the vertebral bodies and the blood Wassermann reaction was negative. It was concluded that the origin was arteriosclerotic.

In another patient, aged fifty-eight, in



FIG. 5. E. Y., aged sixty-nine. Blood pressure 160/110. Aortogram shows fusiform aneurysm and tortuous aorta.

whom a pulsating epigastric mass was thought clinically to represent an aneurysm, aortography was normal. Subsequently at operation it was found that the mass was an enlarged fibrotic pancreas transmitting an underlying aortic pulsation.

Intravenous urography, performed on one patient from our series who had severe hypertension, revealed a calcium ring 2 cm. in diameter within the kidney area. It was thought that a renal aneurysm might exist and might possibly represent the cause of the hypertension. Aortography showed the calcium shadow filled with opaque material. It overlay the upper pole of the kidney but did not belong to the renal artery or its branches which were well shown. The patient died in heart failure and uremia several months later during a second hospital admission. Post-mortem examination revealed a splenic aneurysm corresponding to that seen on the arteriogram and confirmed the interpretation that the aneurysm was not renal in origin. The aortogram of this case has been previously reported by one of us.<sup>1</sup>

Figure 6 shows a small congenital berry aneurysm at the bifurcation angle of one of the branches of the splenic artery. Repeat arteriography confirmed the constancy of this defect. These aneurysms are of surgical interest, since rupture may occur,<sup>2</sup> producing severe hemorrhage (abdominal apoplexy) analogous to the more frequent condition in the circle of Willis.

2. *Complete Aortic Occlusion.* In 2 of our patients, aortograms revealed a complete block at the level of the second lumbar vertebra just below the origin of the renal arteries. Aortic pulsations could not be detected in either patient and arterial pulsations, including the femoral, were not palpable in the lower extremities. Both patients had severe hypertension. An abundant paravertebral arterial anastomosis was demonstrated as well as a large anastomotic channel connecting the middle and left colic arteries. One patient died in uremia ten and a half months later, at which time postmortem examination re-



FIG. 6. V. B., aged twenty-five. Blood pressure 220/130. Arteriogram shows small "congenital" berry aneurysm at bifurcation angle of one of branches of splenic artery (puncture at level of lower border of first lumbar vertebra).

vealed solid thrombosis of the entire aorta below the level of the renal arteries and confirmed the findings of arteriography. The other patient improved somewhat following anticoagulation therapy, vasodilator drugs, and the use of the oscillating bed. One year later he remained slightly improved but still unable to work because of intermittent claudication. Two additional aortograms confirmed the existence of the block. Detailed reports of these cases, including the aortograms and pathologic specimen, will be presented in a forthcoming article.<sup>3</sup>

3. *Peripheral Vascular Disease.* Femoral arteriography by direct femoral injection has been shown to be hazardous, because of induced vasospasm, in patients who already have ischemic lower extremities.<sup>4</sup> It is possible that introduction of the needle well above the site of maximal involvement might lessen the danger of arteriospasm. Aortic injection at the level of the third



FIG. 7. R. T., aged forty-two. Blood pressure normal. *A*, lower aorta and iliac system well shown following injection at level of third lumbar vertebra. Compare the relatively smooth contour of these vessels with those in Figure 8. *B*, femoral arteriograms obtained simultaneously with aortogram in *A* by means of the portable machine. The left femoral artery is completely occluded and a scant collateral circulation is visualized (amputation below knee performed five months previously). The right femoral artery is occluded at the lower third of the thigh, and descending collaterals are noted at this site (amputation below knee subsequently performed).



FIG. 8. F. R., aged fifty-six. Blood pressure 160/100; ischemic lower extremities; carcinoma of lung.

lumbar vertebra permits excellent visualization of the external and internal iliac arteries as well as the beginning of the femoral artery (Fig. 7*A*). A satisfactory technique is thus available for diagnosis of vascular lesions (aneurysms, arteriovenous fistulas, emboli, arteriosclerotic occlusions) in this area without resort to retrograde methods (arteriography in reflux<sup>5</sup> and retrograde catheterization of the femoral artery<sup>6</sup>). The lower end of the femoral artery and even the popliteal may be visualized on a separate roentgen film if simultaneous exposure is made with the portable machine (Fig. 7*B*).

Figure 8 represents a case of bilateral, far advanced atheromatosis of the femoro-iliac system. The arteriogram shows a block

Aortogram shows extreme atheromatosis of iliac vessels. Both internal iliac arteries as well as the right superficial femoral and left common femoral are blocked.

of both internal iliac arteries, the right superficial femoral (right profunda branch patent), and the left common femoral.

4. *Abdominal Tumors.* Arteriography is of value as an adjunct in the diagnosis of certain abdominal tumors, particularly those retroperitoneal such as renal and adrenal. The extent is usually delineated more clearly than on the plain roentgenogram, and in addition an estimate of the vascularity is obtained. Pooling of radiopaque medium, which evidently occurs in areas of hemorrhage and necrosis within the tumor, is an arteriographic sign highly suggestive of malignancy. Nelson<sup>7</sup> has reported 2 cases in which the diagnosis of hypernephroma of the kidney was made on this basis while the intravenous urograms were still negative. This sign is not pathognomonic of hypernephroma, however, for it was noted in our series in a case of liposarcoma of the kidney.<sup>1</sup>

Occasionally a retroperitoneal tumor is so large as to displace the aorta itself or some of its major branches. In these instances there is usually a pulsation which raises the diagnostic question of aneurysm. Figure 9 represents a case of retroperitoneal fibrosarcoma in the left lower abdominal quadrant with displacement of the aorta and superior mesenteric artery to the right. The possibility of aneurysm was excluded preoperatively by this study.

5. *Hypertension.* By means of abdominal aortography the renal arteries and their branches may be well delineated, and in addition information may be gained concerning the vascularity of the kidney parenchyma. Such a study should aid in determination or exclusion of renal ischemia as the cause for a given case of hypertension. The renal shadows are much denser and sharper on the arteriogram than on the plain roentgenogram. Each kidney shadow may be compared with the opposite kidney on the arteriogram and with its own shadow on the plain film. Greater density with more distinct visualization signifies the presence of a larger quantity of radiopaque material and hence greater vascularity. Unfortunately, at the present time, lack of

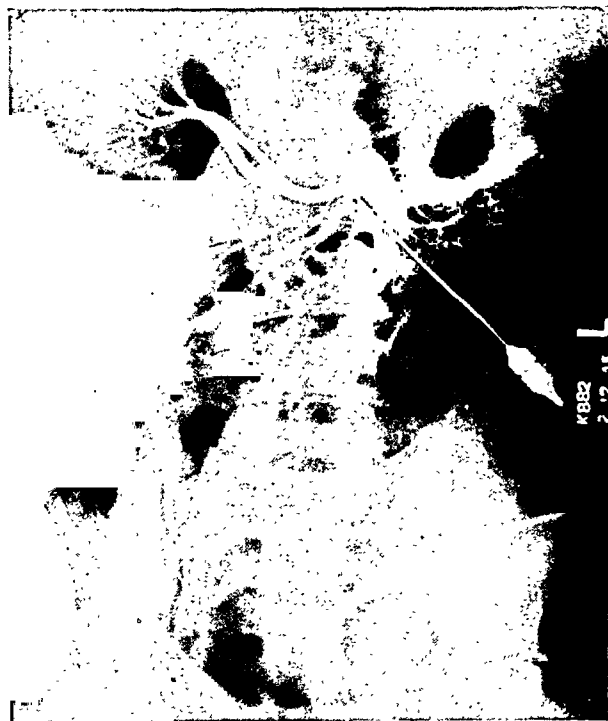


FIG. 9. M. M., aged seventy-one. Blood pressure normal. Aorta and superior mesenteric artery are displaced to the right by a large retroperitoneal fibrosarcoma in the left lower quadrant. Visualization of the hepatic artery and its branches is unusually good.

experience and lack of exact knowledge of the normal range of variation have led to uncertainty in the interpretation of the differences in density noted on the two sides. Further investigation and pooling of information are indicated to establish normal variations in density of the parenchymal shadows. In those cases of hypertension in which the possibility or suspicion of a renal artery lesion exists, arteriography should be employed before proceeding with sympathectomy.

Ten of the patients in this series had hypertension, although hypertension constituted the indication for arteriography in only seven. In one of the cases renal origin of an aneurysm was excluded, while in another fusiform aortic aneurysm was revealed. In 2 cases a complete aortic block just below the origin of the renal arteries was demonstrated. In 3 patients the renal arteries and parenchymal shadows appeared normal (Fig. 10), and no other cause for the hypertension could be proved. Sympathectomy was subsequently per-

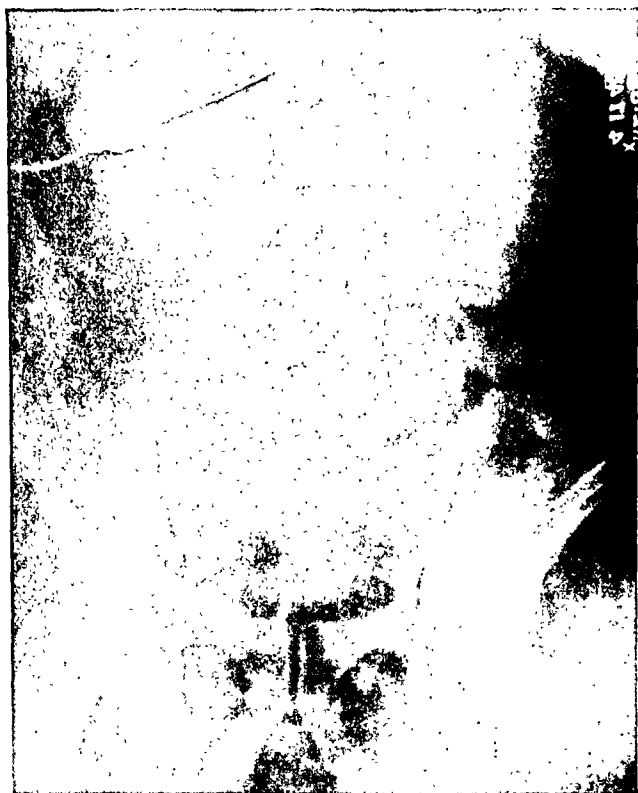


FIG. 10. H. D., aged fifty-one. Blood pressure 220/120. Arteriogram sharply delineates the renal shadows with bilateral equal density. The renal vessels show no defects in outline. Sympathectomy was performed. Note high bifurcation of aorta at lower border of the third lumbar vertebra and tortuosity of iliac vessels.

formed in 2 of these patients and is planned for the third. In one patient with chronic glomerulonephritis in the terminal stage the renal parenchymal shadows appeared less dense than usual, but no defects were noted in the renal arteries and their branches. Of the remaining 2 patients, one had carcinoma of the lung and one, aged seventy-three, had far advanced arteriosclerosis. Visualization of the renal vessels and parenchymal shadows was not entirely satisfactory, but the studies were not repeated because of the poor prognosis.

6. *Hydronephrosis Caused by Aberrant Vessel.* Although we have not had the opportunity to demonstrate an aberrant renal vessel as the cause of hydronephrosis, we would like to include this as another possible diagnostic application of abdominal arteriography. A ureteral catheter should first be passed by a urologist to the point of obstruction. Arteriographic dem-

onstration of an aberrant vessel which passes just at the tip of the catheter should furnish reasonable proof of its role as the causative agent.

#### SUMMARY AND CONCLUSIONS

1. A simple technique of abdominal arteriography is described, featuring the use of a 15 cm. No. 18 gauge malleable needle and a hand syringe for injection. Duties in the team of roentgenologist, anesthetists, and surgeon are outlined.

2. Indications for this study in cases of aneurysm, aortic occlusion, peripheral vascular disease, abdominal tumors, hypertension, and hydronephrosis associated with aberrant vessel are discussed. Illustrative arteriograms are presented.

3. Although abdominal arteriography was performed without untoward results 26 times in this series, it is not without potential dangers. It should be employed as a diagnostic adjunct by carefully trained personnel only after simpler and standard studies have failed to yield sufficient information to reach a necessary conclusion.

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## ABDOMINAL VENOGRAPHY\*

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THIS paper deals with the results we have obtained in venography of the inferior vena cava and iliac veins.

Under local anesthesia the long saphenous vein is exposed by a short incision at the inner portion of the middle third of the thigh. A tourniquet is placed at the groin to make the vein more prominent. The vein is punctured with a small trocar, the tourniquet released and 40 cc. of diodrast rapidly and continuously injected. Sometimes direct puncture of this vein is possible without need of its previous exposure. Two 14 by 17 inch films are taken; the first when 30 to 35 cc. of the opaque medium has been injected and the second immediately afterwards. This is

accomplished by using a fast plate changer. Urograms may then be taken.

In order to create transitory hypertension in the region of the inferior vena cava, compression of the epigastrium with an inflated balloon may be made, thus making visible some of its branches.

This technique offers no more dangers or discomforts to the patient than does intravenous urography, except the incision on the skin.

Normal venography shows the femoral, external and common iliac veins and the inferior vena cava that becomes larger in caliber as it ascends towards the right side of the lumbar vertebrae (Fig. 1). When epigastric compression is used the internal



FIG. 1. Normal venogram showing the normal aspect of the external and common iliac veins and the inferior vena cava.



FIG. 2. Normal venogram. Epigastric compression with an inflated balloon. The internal iliac, renal and suprahepatic veins are visible.

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.





FIG. 3. Thrombophlebitis obstructing the external and common iliac veins and the inferior vena cava. At operation these veins resembled fibrotic cords. Collateral circulation takes place through the anastomosis of the epigastric and internal mammary veins.

iliac vein and the base of the renal and hepatic veins may become apparent (Fig. 2). There are no abnormally dilated collateral veins.

Indications for the use of this method are more or less definite: (1) Cases where



FIG. 5. Marked compression of the inferior vena cava by a large right renal tumor. Urogram shows a non-functioning right kidney.

there is possibility of obstruction or thrombosis of the inferior vena cava. (2) Abdominal tumors, especially renal neoplasms where intravenous urography is indicated.

FIG. 4. Compression of the inferior vena cava by a large splenic tumor.

(3) Liver conditions that lead to portal hypertension with possibility of a portal vein-vena cava anastomosis.

Pathological conditions of the inferior vena cava are clearly demonstrated by this procedure. In cases of thrombophlebitis the obstruction of the vessels and collateral circulation can be easily demonstrated. When this pathological process invades the external iliac, collateral circulation takes place through the anastomosis of the epigastric and internal mammary veins (Fig. 3). In tumors that compress and displace the inferior vena cava and common iliac veins the site of compression and displacement together with the establishment of collateral circulation can be demonstrated (Fig. 3). It is interesting to study collateral circulation in cases of hypertension in the vicinity of the inferior vena cava. When the iliac veins are permeable

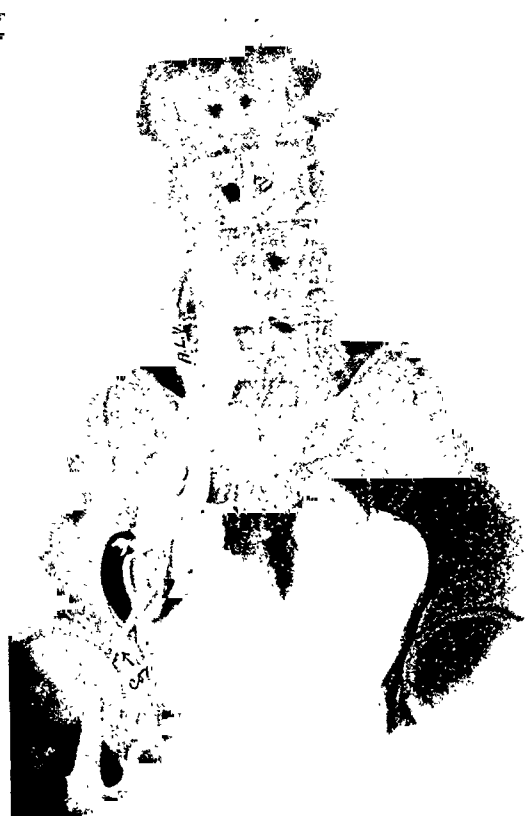


FIG. 6. Abdominal metastasis from a tumor of the testis. Observe the marked compression of the external iliac vein and the collateral circulation established through the iliolumbar, lumbar and ascending lumbar veins.



FIG. 7. Large epigastric tumor producing obstruction of the common iliac vein. Observe the collateral circulation established through the ascending lumbar veins.

there is abnormal enlargement of the venous plexus establishing the collateral circulation and we will see enlargement of the iliolumbar (branches of the internal iliac), the lumbar and the ascending lumbar veins. These last branches unite with the intercostal veins to form the beginning of the vena azygos (Fig. 4 and 5). When the external iliac veins are obstructed collateral circulation takes place following the anastomosis of the internal mammary and the epigastric veins. When anastomosis of the portal vein and vena cava is contemplated, it is very important to take into consideration the permeability of the inferior vena cava, because it is this vessel that will relieve the portal circulation. Venography through the saphena in cases of anastomosis of the trunks of the inferior vena cava and portal vein shows the venous circulation of both trunks; and may show renal vein, branch



FIG. 8. Hypertrophic cirrhosis with compression of the inferior vena cava at its sulcus in the liver. Observe the collateral circulation established through the ascending lumbar veins.

of the vena cava and the hepatic vein, branch of the portal vein (Fig. 6).

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#### DISCUSSION

DR. LEO G. RIGLER, Minneapolis, Minnesota. As is their custom, our Cuban friends present us with a daring departure in the field of roentgen diagnosis; any extension of our vision into that large hidden anatomical space which was so aptly named the abdomen is certainly welcome, no matter how limited the indications for its application may be.

I want to re-emphasize what Dr. Fariñas already has said in his paper, namely that the surgeon now can remove thrombi from the veins, even from the vena cava with a considerable degree of success so that any procedure which will permit us to demonstrate occlusion of the vena cava is now particularly valuable.

Only last week we saw a patient in whom



FIG. 9. Anastomosis of the portal vein and inferior vena cava showing the trunks of both vessels and the renal and hepatic veins.

there was grave doubt as to whether a thrombus was present and we debated back and forth whether or not there was a thrombus; or whether or not the surgeon should operate; he didn't and he should have. In all probability if this technique had been available to us we might well have used it to demonstrate effectively that the thrombus was present, and some possibility at least for saving this patient's life would have been presented.

Again Dr. Fariñas has said this is becoming more and more important as a diagnostic procedure in cases of cirrhosis of the liver, and there too it is of considerable importance to be able to demonstrate the integrity of the vena cava before a shunting operation is performed. There are occasional obstructions of the vena cava which simulate very closely constrictive pericarditis or cirrhosis of the liver and the differential diagnosis may modify very seriously the eventual treatment. Under such circumstances, too, this procedure would be, I am sure, of considerable value.

I have nothing to contribute to the specific method as I have had no personal experience with it.

# CLINICAL AND ROENTGENOLOGIC EVALUATION OF VENOGRAPHY\*

BASED ON AN EXPERIENCE IN 1,027 CASES

By EDGAR C. BAKER, M.D.

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ALTHOUGH venography is a relatively recent achievement of clinical radiology, and still is not widely practiced, it is interesting that one of the very first roentgenograms ever made indicated the possibility of this development. In January, 1896, Haschek and Lindenthal injected Teichmann's mixture into an amputated hand, and made a roentgenogram which visualized the veins clearly.<sup>33</sup> This was one of the first roentgenograms to reach this country, and was the second ever published here.<sup>27</sup> Nevertheless, clinical application of this idea had to await further technical development, particularly of suitable, non-irritating contrast media.

Some work had been done both in Europe and this country before I began my own investigations, in 1941. These were started without reference to what others had done, and throughout have been pursued independently. Hence my technique, interpretations and conclusions differ in some respects from those of others who have worked with venography. From the beginning, the whole approach and handling of the problem has been dominated by thinking in terms of physiology, rather than of anatomy. As the work has progressed, the importance of the physiologic viewpoint has constantly been confirmed, and has been the most significant factor in development of the technique and of the interpretations. *Venography is a physiologic procedure*, and can be properly understood and evaluated only from that standpoint.

The work was undertaken originally to determine whether a technique could be developed that would give significant information to the surgeon regarding the site of block in cases of acute post-surgical

thrombosis and of chronic disease of veins. As a preliminary step, investigations were made on patients with normal leg veins who were being subjected to intravenous urography; the dye was merely injected into a small vein in the foot or ankle instead of into the arm. These first studies emphasized an important physiologic fact—that venous return from the legs is considerably slower than that from the arm, since there is a lapse of seven or eight minutes before the dye is well visualized in the kidneys. It might be mentioned that as a result of this experience, the leg veins are now quite frequently used in urographic work in patients whose arm veins are difficult to puncture. It is also curious that injection of dye into the veins of the leg apparently causes fewer and less pronounced reactions than have been observed following injection into the cubital fossa.

From the start, it was evident that adequate roentgenographic examination of venous function in the legs cannot be made with a single exposure,<sup>7</sup> since physiologic changes are generally quite rapid and variable. Roentgen cinematography would be ideal for this type of study, but since practical apparatus of this type is still not generally available, the problem must be solved by a serial method practicable for clinical use. The technique I use has been described previously<sup>5,6</sup> but since my interpretations depend so largely on the method of visualization, the procedure will be reviewed briefly here.

## TECHNIQUE

Diodrast is used as the contrast medium for this work and to date has caused no severe reactions. All patients receive the Dolan-mouth test for idiosyncrasy to io-

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

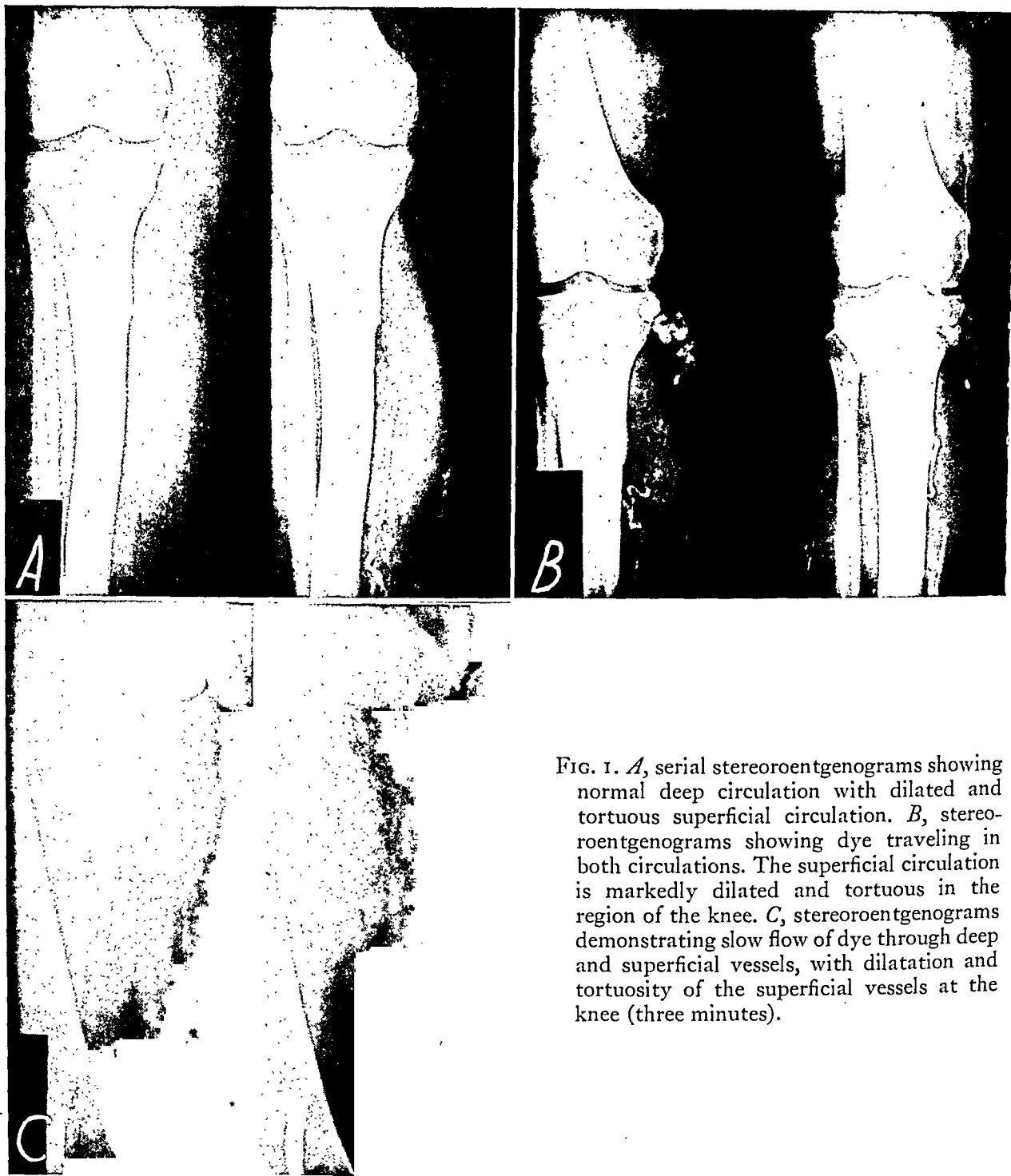


FIG. 1. *A*, serial stereoroentgenograms showing normal deep circulation with dilated and tortuous superficial circulation. *B*, stereoroentgenograms showing dye traveling in both circulations. The superficial circulation is markedly dilated and tortuous in the region of the knee. *C*, stereoroentgenograms demonstrating slow flow of dye through deep and superficial vessels, with dilatation and tortuosity of the superficial vessels at the knee (three minutes).

dides prior to injection. If this reaction is positive, no venogram is made. When bilateral venograms of the legs are required, the examinations are made at least a day apart, to avoid any possible danger of toxicity from diodrast.

Venipuncture is made through the skin (without incision) into any accessible vein below the ankle. A tourniquet is used only as an aid in visualizing the vein and is

removed before the injection is started. The exact point of injection makes surprisingly little difference as to the manner in which it traverses the venous structures of the leg. If the injection is made under the external malleolus, slightly more dye apparently passes up the external venous branches and the external saphenous is more likely to be seen. If a vein on the dorsum of the foot is chosen, the contrast

medium spreads in both directions laterally and internally and then goes around into the posterior veins. If the dye is introduced over the internal malleolus, more of it tends to pass up over the inner and posterior surface of the leg. Twenty cubic centimeters of dye are injected through a No. 25 or 26 gauge needle over a period of three minutes or longer. If the leg appears approximately normal, the dye is injected and exposures are made a little more rapidly. If the leg is swollen, with obvious venous varicosities, the dye is injected more slowly and the films are exposed over a longer period. In this latter type of case, there are the greatest number of incomplete visualizations, owing to slowing of venous circulation.

Three 14 by 17 inch films are used, with two exposures to a film made from stereoscopic positions. Two exposures cover the area from the ankle to the knee; two the area of the upper leg, knee and lower thigh; and two the remainder of the thigh and the lower pelvis. The first exposure is usually made just after the injection of approximately 8 cc. of contrast medium, i.e., forty seconds to one minute after beginning the injection. The other five exposures follow in succession, the last being completed at approximately the time the injection is completed. These exposures give three overlapping pairs of films, including the areas from the ankle to the lower pelvis. With each exposure, the amount of dye injected and the time elapsed from the beginning of the injection are recorded; these data are considered in interpretation of the venogram (Fig. 1, *A*, *B* and *C*).

In 1945, when the shortage of films became acute, some venograms were made with only two exposures. Although the information thus obtained was incomplete, it was often useful for clinical purposes, when interpreted in the light of knowledge gained from previous serial studies. However, even when a complete series of films is taken according to the technique just described, information is often incomplete (Tables IV, VI and VII), because of slow

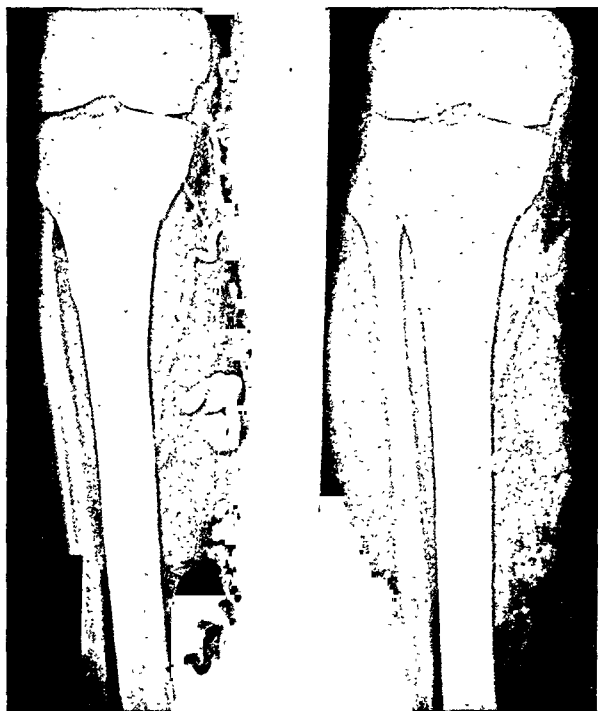


FIG. 2. Stereoroentgenograms demonstrating retarded flow of dye through deep and superficial vessels on film exposed after the usual series of six serial films. The second film shows effect of flexing the knee against the thigh in shunting the dye upward.

passage of contrast medium up the venous channels (Fig. 2).

Venograms have now been made in 1,027 cases. Although in the beginning interest was centered largely on the circulation in the deep veins, particularly in relation to the clinical problem of acute thromboses, as the work has progressed the importance of considering the entire venous system in the legs, i.e., superficial and deep channels, as a single entity, has become increasingly apparent. The significance of any block in the deep veins cannot be properly evaluated unless the findings in the superficial veins are taken into account. Techniques of venography which blot out the superficial channels by use of a tourniquet are bound to give a distorted picture. In experiments in several cases in which the legs were severely swollen, tourniquet pressure was applied during the injection of the first 5 or 6 cc. of contrast medium, and then removed. Apparently there was

no appreciable interference with visualization of the superficial circulation in these cases, but there also was no indication that visualization of the deep veins was improved.

#### NORMAL FINDINGS

In normal subjects, the greater portion of the contrast medium enters the deep circulation fairly close to the ankle through deep communicating veins. A smaller quantity spreads through the superficial plexus, usually demonstrating external veins to the knee. Usually the internal or greater saphenous vein is well visualized. Progress of the dye through both deep and external channels is steadily upward unless disease is present. However, in some subjects, portions of the dye in the superficial veins enters the deep circulation through connecting veins at one or several levels, as it travels upward. Young persons have straight veins, and the dye passes upward more quickly than in older subjects who have slightly tortuous or dilated veins. The progress of the dye through the deep veins is accelerated by exercise. In numerous normal subjects, remaining motionless in the supine position, the dye has remained in the deep veins and some superficial veins from five to twenty minutes after injection. Any movement of the foot or leg, or muscular contraction, apparently forces the dye upward immediately (Fig. 2).

#### PATHOLOGIC CASES

In an earlier report,<sup>6</sup> we analyzed 100 consecutive venograms, and classified them clinically as to whether they showed only superficial block, or superficial and deep block, subdividing acute and chronic processes under both headings. This is the practical information sought by the surgeon in planning treatment. In making the roentgenographic diagnosis, no attempt is made to cite the clinical cause of the block (such as phlebitis, phlebothrombosis, etc.). The classifications, acute and chronic, are based largely on appearance of the veins, i.e., evenness of caliber, extent of tortuosity and dilatation.

In acute superficial block, a portion of the dye enters the deep circulation in the region of the ankle or just above, and the deep circulation is visualized from this point upward to the femoral fossa. The dye spreads throughout the superficial plexus to the site of block. This is most easily demonstrated when the contrast medium stops abruptly at the site of a connecting vessel and turns directly inward or somewhat backward toward the deep circulation or to another region of the superficial plexus. From the point of block upward, no superficial plexus is demonstrated. In another type of acute superficial block, somewhat more difficult to recognize, short lengths of straight, non-tortuous and non-dilated veins extend upward and apparently fade out in the tissues. Recognition of this finding is difficult because the dye may be moving slowly, and a single observation may give incorrect information. Two or preferably four venograms showing the dye fading out at the same point on all exposures yield a definite clue to block above the area where the dye is last visualized. Acute superficial block is frequently superimposed on chronic disease of the deep or superficial circulation.

In chronic superficial block, the veins are dilated and tortuous and passage of the dye upward is usually slow; numerous dilated veins in the superficial tissues which do not fill with dye are usually seen. The deep veins are filled; these may also show some dilatation and slight tortuosity. Frequently, upward passage of the dye in the deep veins is slow. When superficial block is chronic, small connecting veins extend inward toward the deep circulation or outward from the deep circulation for 1 to 3 cm., and appear to end abruptly in the tissues. As with acute superficial block, the dye occasionally turns abruptly inward toward the deep circulation or toward another area of the superficial plexus. Certain areas of superficial circulation also are not demonstrable. It is possible to overlook an acute block in a leg showing an extensive chronic block.

In acute partial or complete block of the deep circulation of the leg and thigh, definite evidence of acute block in the superficial circulation is always demonstrable; this fact supports the theory that deep, acute phlebitis originates primarily in the superficial circulation. With either acute or chronic block of the deep veins, the deep circulation in the involved area cannot be visualized. Differentiation of these two conditions is made on the basis of the appearance of the superficial circulation. In the acute process involving the deep circulation, the superficial circulation presents essentially the same appearance as in acute superficial block. Occasionally, a superficial vein is partly outlined by the dye, indicating presence of a thrombus. In a few instances of acute block of deep veins, a small portion of dye may find its way into the deep circulation and reveal a thrombotic process there.

Chronic block of deep veins is the most easily recognized finding in venograms. The deep circulation is completely or partly absent. The dye usually enters branches of the internal saphenous promptly, and by the time the region of the knee is reached, all the dye is returning upward through that vein. The entire internal saphenous is dilated to the femoral fossa, is usually quite tortuous, and upward passage of the diodrast is considerably slowed. Short lengths of communicating veins emerge from the internal saphenous to fade out into the tissues; these are considerably larger than normal and frequently exceedingly tortuous. When chronic block involves only the deep veins of the leg, most of the dye returns by communicating veins above the knee to the femoral vein.

Patients with a complete block of the entire deep circulation of the leg and thigh frequently show very large, dilated, superficial varicosities; vessels of this type, as the venogram shows, are main channels for carrying blood upward to the femoral fossa. Clinical tests in such cases may be misleading in apparently demonstrating a competent deep circulation where none exists.

The venogram gives practical information of great clinical importance in such instances, because ligation of superficial varicose veins when the deep channels are not patent always aggravates the circulatory difficulty and may lead to serious trouble.

Thrombi produce three different types of shadow. In one, there is a sudden block and the head of the column of dye at this site is concave and indicates that the lumen of the vein contains a mass that is beginning to be outlined by the contrast medium. In another type, the vein is not completely obliterated, but shows a ragged, irregular area extending for a short or longer distance along the wall. With the third type, the dye follows the wall of the vein and definitely outlines a mass within the lumen.

These differentiations between acute and chronic processes are made roentgenographically without reference to the results of clinical tests or the diagnosis made by the surgeon. The final diagnosis, of course, is made by correlation of clinical findings with the information obtained by venography. In many instances, the latter procedure adds valuable information or proves to be much more accurate than the original clinical impression. After an experience extending over several years, the surgeons in our hospital are now convinced of the clinical value of venography, and would not perform any surgical procedure on the veins of the legs, either in acute or chronic conditions, without it.

#### ROENTGENOGRAPHIC ANALYSIS OF 100 VENOGRAMS OF THE LEGS

Recently I have analyzed a series of 100 serial venograms from the standpoint of roentgenographic rather than clinical information. These venograms were reviewed critically in an attempt to determine just how much information they furnish. Tabulations were made to show in what proportion of cases, with the technique used, satisfactory visualization of the principal venous channels of the leg is being obtained; and to determine, as far as possible,



the evidence and reasons for partial or complete lack of visualization in the different veins. These cases were unselected, except that those in which only two exposures were made, owing to the film shortage, were excluded, so that the material would be consistent and adequate for comparative analysis.

In these 100 cases, complete visualization was obtained in thirty-three. In the 67 cases in which visualization was not complete in all veins, the information obtained was satisfactory, from the standpoint of making a roentgenographic diagnosis, in forty-six. That is, in 4 of 5 cases, definite conclusions could be drawn from the information obtained by venography.

TABLE I

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG  
VENOGRAMS: EVIDENCE OF SUPER-  
FICIAL BLOCK

Complete visualization	33
Evidence of superficial block	29
Partial visualization	67
Evidence of superficial block	55
Information satisfactory	46

In the 100 cases analyzed from another standpoint and reported previously, there were only 2 cases in which no definite conclusions could be made. Although I have not subjected the entire series to detailed analysis, it is my impression that the proportion in which venographic information is unsatisfactory is no more than 10 or 12 per cent for the group as a whole.

Evidence of superficial block occurred in 84 per cent of this series (Table I), and was considered the finding accounting for lack of visualization in other veins in 24 of the 67 cases in which visualization was incomplete. Another important reason for incomplete visualization of all veins in the leg is improper timing in pathologic cases. Despite the fact that when there is swelling or other gross manifestation of impaired venous function, the dye is injected more slowly and the film exposures delayed, there was evidence in this series that the

femoral or internal saphenous veins, or both, were not visualized in 19 cases (although in 10 of these the clinical information was satisfactory), because the contrast medium had not reached this level at the time the last exposures were made. Additional films undoubtedly would have completed the venographic findings in these cases. I stress this point particularly, because this fact apparently is not considered at all by some authors who have reported roentgenographic studies on veins, since their techniques involve a single exposure, sometimes with a tourniquet applied to block out the superficial channels.<sup>9,15,19,24,37,55,60</sup> If, with my technique of six serial films made with delayed exposures in cases exhibiting gross evidence of sluggish circulation, visualization is incomplete in 19 per cent because of improper timing (adequate timing in the individual case is difficult to estimate), it seems obvious that a single, rapidly timed exposure might produce a venogram that would be wholly misleading. Indeed, there were many cases in this small series in which a single film would give a mistaken impression. This was also the experience when an attempt was made to prepare venograms with only two films (during the shortage). Although, in the light of previous studies, these examinations yielded some information, it was always incomplete, and very often unsatisfactory.

The number of times the principal venous routes (i.e., deep veins, femoral and internal saphenous veins) were visualized completely or partially is shown in Tables II and III. Evidence for lack of visualization, as determined by this analysis, is also tabulated for each main channel (Tables V, VI and VII). In a few instances, no roentgenologic evidence to account for lack of visualization could be found. (Improper timing might have been a factor in these instances also, but it could not be proved from the venogram.)

This analysis revealed that a particular type of case in which only the internal saphenous is visualized—previously inter-

preted as evidence of deep block—showed no obvious roentgenographic evidence for this interpretation other than non-visualization of the deep veins. Repeated examinations made later in these cases have shown that when a tourniquet is applied during injection, there is roentgenographic evidence of a highly incompetent deep circulation, but no actual block. In my experience, this is the only type of case in which application of a tourniquet has any practical value in yielding better visualiza-

TABLE II

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: VISUALIZATION OF INDIVIDUAL VEINS

	Seen	Partially Seen	Not Seen
Deep veins	68	4	28
Femoral vein	70	9	21
Internal saphenous vein	58	28	14
Profunda	1		

TABLE III

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: VISUALIZATION OF COMBINATIONS OF VEINS

	Complete	One Partial	Both Partial
Deep, femoral and internal saphenous	33		
Femoral and deep	61	7	2
Femoral and internal saphenous	40	21	5
Deep and internal saphenous	34	24	1

TABLE IV

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: PARTIAL VISUALIZATION

Partial visualization caused by		
Superficial block in		24
Deep veins	7	
Deep and femoral veins	9	
Internal saphenous vein	8	
Improper timing		19
Information satisfactory	10	

TABLE V

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: DEEP VEINS

	Seen	Not Seen Because	Partially Seen Because
Blocked			4
Evidence of superficial block		16	
Other roentgenographic findings		7	
No roentgenographic evidence		5	
Total	68	28	4

TABLE VI

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: FEMORAL VEIN

	Seen	Not Seen Because	Partially Seen Because
Block in deep veins		1	
Evidence of superficial block		9	
Other roentgenographic findings		6	
Improper timing		1	9
No roentgenographic findings		4	
Total	70	21	9

TABLE VII

ROENTGENOGRAPHIC ANALYSIS OF 100 LEG VENOGRAMS: INTERNAL SAPHENOUS

	Seen	Not Seen Because	Partially Seen Because
Blocked		2	16
Evidence of superficial block		8	
Improper timing		2	12
No roentgenographic evidence			
Total	58	14	28

tion of the deep circulation than can be obtained without it.

This detailed analysis from the standpoint of roentgenologic visualization confirms once more the results and impressions of earlier studies—that the entire venous plexus of the legs, comprising both superficial and deep veins, must be considered as a single entity, and that the superficial plexus is of paramount importance in any consideration of venous pathology. In fact, the venographic evidence indicates that all disease processes involving any of the leg veins start there, for there are many cases in which only the superficial veins are involved, with the deep venous channels functioning normally; but in any case in which the deep veins are blocked, there is always evidence of superficial block also. This fact is important and significant, not only in providing specific information as a guide to treatment of the individual clinical case, but also in focusing attention on a possible clue to the pathogenesis and prevention of venous disease.

It seems evident from the large number of venograms I have studied in all types of pathologic cases and normal subjects that acute postoperative thrombosis may be a preventable condition. Numerous pathologic investigations<sup>35,36,46,51</sup> have demonstrated that the thrombi originate in small deep veins in the feet or lower part of the leg, and that they extend upward through the larger veins to reach the femoral or iliac veins, where they may break off to cause fatal pulmonary embolism.<sup>12,13</sup> Most theories postulate some injury to the intima of the vessel as the starting point of thrombus formation, but no adequate explanation has been offered as to how the intima of a small deep vein becomes injured while a patient is lying quietly in bed. It seems more logical to suppose that such an injury would occur in a superficial vein, a supposition supported by venographic evidence of thrombotic processes in superficial and connecting veins in cases of acute block of the deep leg veins.

A superficial bruise is one of the most

common injuries—so common that it is ordinarily considered of no consequence. It is completely commonplace to notice a bruise at a certain site when the original trauma which caused it was not noticed or remembered. In persons with an intact, normally functioning venous system, a superficial bruise involving a small vessel is of no consequence, for spasm of the vessel initiated by the inflammation arrests the process before it extends into the deep circulation. However, after an operation, numerous abnormal factors may contribute to extension of the thrombotic area from a superficial bruise on the feet or legs (which certainly could easily be produced in an anesthetized patient on the operating table or in moving him on or off the cart or the bed).

A surgical procedure initiates a chain of events producing biochemical changes in the blood that favor increased clotting.<sup>20,21,47,58</sup> It is customary also to immobilize the patient in a supine position for a considerable period after operation. Venographic studies<sup>7,42</sup> have shown that, even in a normal subject who remains supine and motionless, venous return from the legs may be greatly delayed, but that movement of the feet or legs will immediately shunt the venous blood flow upward. The role of bed confinement in production of postoperative thrombosis has been widely recognized recently,<sup>22,32,35,39,47</sup> and is one of the important factors influencing the trend toward exercise and ambulation during the immediate postoperative period.<sup>39</sup> Venographic evidence as to the effect of exercise on the deep venous circulation of the legs would indicate that this is sound prophylaxis against thrombosis.

Another factor which may contribute to extension of a superficial thrombotic process into the deep leg veins is a previously impaired and sluggish venous circulation. Frimann-Dahl<sup>32</sup> found venous circulation of the legs greatly retarded in postoperative patients presenting increased risk of thrombosis and embolism. Shafiroff and his associates<sup>54</sup> reported that in patients with

diseased legs, there is increased coagulability of venous blood also. Statistics<sup>3,10,11</sup> showing that the incidence of postoperative thrombosis is higher in women, particularly after gynecologic operations, the aged, those with a debilitating disease such as cancer, and in patients who have had previous thrombotic episodes, corroborate the idea that thrombosis is more likely to occur in patients with impaired venous systems.

Patients with chronic varicose veins are subject to acute exacerbations, reflected in venograms by evidence of spasm, acute block—sometimes with thrombus formation—superimposed on the chronic pathologic condition. Thus it would appear that any pathologic process in the venous system of the legs may be a precursor of involvement in other regions of the superficial or deep plexus, or both. For this reason, the evidence of superficial block furnished by venograms cannot be ignored. The acute process may become chronic, or leave a chronic residue, and chronic disease may be the basis for additional acute episodes.

Most venographic studies reported by others have been directed toward early diagnosis of acute thrombosis of deep leg veins as a basis for inaugurating surgical or medical treatment to prevent embolism, but it would appear that the evidence furnished by venograms might be applied also in attempting to decrease the incidence of venous disease. Any such attempt should take into account the possible significance of superficial bruises under certain conditions, especially when the function of the veins is already damaged; evaluation of the status of venous circulation in the legs as determined by history and clinical examinations so that precautions and protective measures may be instituted as indicated, and the importance of exercise in maintaining circulatory function in the legs during illness, particularly postoperative illness.

#### DISCUSSION

Although, as already mentioned, the veins were visualized in an anatomic speci-

men by injection of a contrast medium into the veins of the hand, within a few weeks after the discovery of the roentgen rays, apparently no physiologic experiments were attempted along this line until 1910, when Frank and Alwens<sup>30</sup> injected Wismutöl into the veins and heart of animals and studied the circulation under the roentgen ray. Berberich and Hirsch<sup>18</sup> seem to have been the first to make experimental venographic studies on human beings. They used a solution of strontium bromide, and reported on studies of the arm veins in 1923. They proposed a systematic study of all the veins and arteries of the extremities by this method, and visualized venous valves, collateral veins and the arterial circulation of the hand. The advent of uroselectan as a contrast medium furnished impetus to this type of study, and several European investigations were reported in the early thirties. Ratschow<sup>50</sup> first used this material in 1930 in animal experiments and later on patients. He described injections into the arm and also injected the dye into varicosities of the legs in 4 cases. Sgalitzer, Kollert and Demel<sup>53</sup> (1931) also demonstrated varicosities by direct injection. Wohlleben<sup>52, 61, 62</sup> described both experimental and clinical investigations, in 1932 and 1933, using abrodil as a contrast medium.

In 1932, Barber and Orley,<sup>8</sup> in England, described their findings in 30 cases of varicose disease of the leg, using abrodil, and making two exposures from stereoscopic positions. They reported that normally the internal saphenous veins showed slight dilatation at the level of the internal condyle of the tibia, corresponding with a constant valve in this situation. They observed that return of flow in both normal and pathologic cases was influenced by posture, rest, muscular activity and respiration.

In the United States, McPheeters and Rice<sup>45</sup> attempted in 1929 to study the circulation and direction of venous flow in cases of varicose veins by following roentgenoscopically the course of droplets of lipiodol, but could not outline the venous channels

by this method. In 1933, Pomeranz and Tunick<sup>49</sup> reported varicography with skiodan by roentgenoscopic observation of the circulation of the blood in the diseased veins and its variations during changing mechanical conditions; they demonstrated venous pools and feeder veins in the vicinity of varicose ulcers. Edwards published two reports<sup>25,26</sup> on vasography in 1933 and 1934, the latter with Biguria. These authors compared skiodan and diodrast as contrast media, and concluded that diodrast was less irritating than skiodan, but that it produced considerable fall in blood pressure. Veal and McFetridge<sup>56</sup> reported on venography for thrombosis of the axillary vein, using thorium dioxide, in 1935.

A preliminary study on roentgenologic visualization of the veins of the extremities with thorium dioxide sol was published from the Mayo Clinic in 1934 by Allen and Barker.<sup>2</sup> Two years later, Barker and Camp<sup>9</sup> reported successful venograms made with diodrast in 37 cases, 19 of which were of the lower extremities, and claimed priority in the study of obstructive lesions of the veins. Injection was made at different sites according to the vein to be visualized. Injection of 20 cc. of diodrast was completed in the leg in fifteen to eighteen seconds and the roentgenogram was made immediately afterward. They reported that in obstructive lesions of the long saphenous vein, diodrast entered a few collateral channels below the point of occlusion, uniting again in the external, superficial or deep femoral veins; in obstructive lesions of the short saphenous vein it passed through collateral channels over into the long saphenous system.

Dos Santos<sup>23</sup> was a pioneer in direct venography and results of his early work were published in 1938. The method has also been used by other South American investigators,<sup>38</sup> but these papers have not been available to me for detailed review.

During the 1930's, interest in venography was also exhibited by Scandinavian investigators, and the method has received extensive study there. Frimann-Dahl<sup>32</sup> in

1935 reported a comprehensive roentgenographic study attempting to elucidate the causes of acute thrombosis. He used parabrodil as contrast medium, and made two exposures, five seconds to two minutes apart, and recommended timing the films according to the rate of blood flow. The venous blood stream, particularly in the legs, was examined by this method before and after operation in 29 patients presenting increased risk of embolism, and compared with that in 8 patients in whom there was no increased risk of embolism. He found that after operations on the former group, there was a pronounced retardation of venous blood flow; in some instances, the blood almost came to a standstill. In other cases, there was retardation of lesser degree. In several cases, there was evidence of retrograde flow. In 2 cases with severely retarded blood flow, formation of thrombi was observed in the leg veins. On the basis of this study, he recommended active movement of the lower extremities as prophylaxis against thrombosis.

Lindblom<sup>42</sup> reported venographic studies of the leg following injection of perabrodil into a subcutaneous vein and described a serial technique in which exposures were made at zero, one-half and two minutes, and occasionally at four minutes. He made roentgenograms both with the patients supine and upright, and stressed the value of foot movements and of flexion of the knee in securing good exposures.

Bauer's work on venography of the lower extremity in both acute thrombosis and chronic venous disease has been extensive and correlated with thorough and painstaking clinical studies, particularly on administration of heparin in early cases to prevent serious sequelae. His first work on thrombo-embolic problems was published in 1940;<sup>12</sup> later extensive studies were brought together in a roentgenologic and clinical study of the sequelae of thrombosis in 1942.<sup>15</sup> Bauer's contributions<sup>12-17</sup> are of great importance in this field, and he has stimulated many others to work along these lines. The validity of many of his observa-

tions and conclusions cannot be questioned, for his work rests on a sound clinical foundation. Although his venograms have yielded him much useful clinical information, this must sometimes be misleading, since the information obtainable with the technique he employs is only partial. This has necessitated interpretations based on deductions, in some instances, rather than on actual roentgenographic evidence. Bauer's deductions and interpretations are often sound, but in some particulars might be open to question on the basis of knowledge gained from extensive study of serial venograms yielding much more complete information.

Much of the work in the United States since 1940 has been stimulated and directly or indirectly influenced by Bauer's work, to greater or lesser degree. The majority of American investigators<sup>4,19,24,29,37,40,41,44,48,55,57,59</sup> have used Bauer's technique, or some modification of it, and have offered similar interpretations of venograms. With most of the techniques, a tourniquet or bandage is used to force the contrast medium into the deep veins, and a single exposure is made, at the completion of the injection, which is carried out fairly rapidly and at a uniform rate for all types of cases. The emphasis in most of these studies has been on the diagnosis of acute thrombophlebitis. Some useful results have been obtained, but they have not been completely satisfactory, and in some instances,<sup>1</sup> considerable doubt has arisen concerning the value of venography in such cases.

My experience has shown that information obtained by a single exposure is only partial and may often be misleading and of doubtful value in the individual case. Serial roentgenograms are necessary to get any sort of complete information; timing is extremely important in getting a true roentgenologic picture in pathologic cases in which the circulation is sluggish, and the most important feature of the interpretation is a consideration of the status of the superficial veins (completely ignored in

most other techniques) in relation to that of the deep circulation.

The surgeons in our hospital are enthusiastic about the value of venography in their clinical work. Hence it would seem that repudiation of venography by others should be postponed until more complete roentgenographic methods have been tried, including serial exposures and more comprehensive interpretations, with consideration of the whole network of veins, both superficial and deep, as an entity.

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#### DISCUSSION

DR. G. W. HEUBLEIN, Hartford, Conn. Dr. Baker's work based on his experience in several hundred cases of venography is a very real contribution to clinical roentgenology. He shows that in the hands of an experienced individual this type of examination can be of considerable aid.

I should like to re-emphasize one of Dr. Baker's statements. "The final diagnosis, of

course, is made by correlation of clinical findings with the information obtained by venography. In many instances the latter procedure adds valuable information or proves to be much more accurate than the original clinical impression. After an experience extending over several years, the surgeons in our hospital now are convinced of the clinical value of venography, and would not perform any surgical procedure on the veins of the legs, either in acute or chronic conditions, without it." This statement is important, since in certain sections of this country the value of venography is questioned, and in some instances the procedure has been largely abandoned. Whether this is due to lack of appreciation of the value of the method, to lack of interest, or incomplete knowledge of the method of examination and the interpretation of the findings on the part of the examiner cannot be stated. There is no doubt, however, that if one expects to do this type of work, he should thoroughly familiarize himself with the normal as well as the abnormal response in the particular method of examination employed. Fortunately this type of examination lends itself readily to such investigation.

The author's method is a relatively simple and safe procedure. The fact that there are fewer and less pronounced reactions is not surprising, since vasomotor disturbances due to diodrast result from the concentration of the dye in the circulating blood. The paucity of reactions may therefore be explained by the fact that it takes longer for the diodrast to reach the cerebral and pulmonary areas, and when this occurs it does so in more dilute form.

Dr. Baker has directed our attention to the importance of superficial venous block in the presence of deep venous plexus involvement, either acute or chronic. In this regard, I should like to inquire whether or not he feels it is possible for superficial block to be simulated by vascular spasm secondary to thrombosis of the deep venous system.

From Dr. Baker's findings and hypothesis that injury to the vascular intima occurs first in the superficial vessels and subsequently leads to the formation of deeper thrombi, the logical conclusion follows that more attention than has been in the past should be paid to the superficial circulatory channels.

It is an accepted clinical fact that early ambulation has very materially reduced the incidence of postoperative pulmonary complica-



tions due to phlebothrombosis. Such complications, occurring formerly in 1 out of 700 cases, has been reduced to the neighborhood of approximately 1 to 1,000. Dr. Baker's statement that he has seen dye in the deep and superficial veins as late as twenty minutes after injection is therefore of more than passing interest. He has presented graphic evidence that exercise is a sound prophylactic measure. On the other hand, that this is not the entire story is shown by the fact that even after early ambulation, patients who have returned home two or three days postoperatively may die of a massive pulmonary embolus resulting from an unsuspected phlebothrombosis.

Unfortunately the uninfected clot, which is relatively asymptomatic, is most likely to be fatal. Symptoms when they do occur are so transient that they often are overlooked. Because it is difficult to pick the case which will be a potential trouble-maker, in some sections it has become customary to tie off the veins of

elderly patients as a prophylactic measure in much the same manner as the vas is ligated in prostatic surgery.

It is to be hoped that by means of venography such cases can be picked more intelligently and that ligation as a purely routine measure will be abandoned. It is quite apparent that the physician must be either superconscious or superhuman in order to diagnose the presence of a sterile clot without some such procedure as venography.

Dr. Baker is to be congratulated on his excellent presentation.

DR. BAKER (closing). Dr. Heublein asked if spasm simulated block. In my opinion, it does not. The two have a different appearance on the roentgenogram. The spasm you can see by constriction of the vessels which relax above the area of spasm and which changes from film to film and with block the area that is blotted out is constant.



# ROENTGEN VISUALIZATION OF THE INFERIOR VENA CAVA\*

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A SIMPLE, safe method for the contrast roentgen visualization of the inferior vena cava is presented. This examination was prompted in our case by the desire of the urologist to demonstrate the relationship between an anomalous ureter and the vena cava.<sup>3</sup> These, our first "cavograms," are illustrated in Figures 1, 2, 3, 4 and 5. It is believed that many indications for such an examination exist and these will be the basis of another study. Contraindications at present are few and are identical with those against intravenous urography.<sup>6,7,9</sup>

The original caval visualization, which was performed in 1935 by dos Santos,<sup>1</sup> was an unsuccessful attempt to portray a damaged vena cava following nephrectomy. His was a rather complicated and a considerably more hazardous procedure than the one presented here. This may account for the apparent lack of interest in, and development of, his technique.

## METHOD

The patient, having been prepared as for intravenous urography, is placed supine upon a roentgen examining table tilted cephalad about 5 degrees from the horizontal. Sphygmomanometer cuffs are placed about both thighs as far proximally as is possible, leaving room for femoral venipuncture on the side selected. The femoral triangle is then prepared for aseptic venipuncture. With one hand palpating the femoral artery, a No. 18 needle on a syringe containing 35 per cent diodrast (neoskiodan) is inserted into the femoral vein. The manometers are then adjusted to approximately diastolic blood pressure or a little above and the diodrast is injected with moderate rapidity (1 cc. per second). In twenty seconds (20 cc. having been in-

jected) the usual kidney-ureter-bladder exposure is made to outline the external and common iliac veins and the inferior vena cava. Removal of the sphygmomanometer cuffs with release of the dammed-up venous blood from the lower extremities



FIG. 1. Normal cavogram with circumcaval ureter.

probably washes out and dilutes the slightly thrombogenic influences of the diodrast.

## DISCUSSION

Having the patient hold his breath during injection and exposure tends to make the blood column move more slowly and more smoothly.<sup>4</sup> A Valsalva effort, however, may, by increasing the intra-abdominal pressure slow the blood column or reverse

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FIG. 2. Normal cavogram with spondylitis rhizomelica.



FIG. 3. Normal cavogram with suprarenal calcification. Here compression over the liver partially occludes the vena cava while the patient is in deep expiration.



FIG. 4. Normal cavogram.



FIG. 5. Normal cavogram.

its flow sufficiently to demonstrate the tributaries and branches of the iliac veins. The vena cava is usually emptied of the opaque medium in this procedure. Lateral, oblique, and stereoscopic projections may be made when indicated. If a more dense shadow of the vena cava is desired, 70 per cent diodrast may be used. Although the manufacturer and some authors minimize the sclerosing tendencies of the more concentrated preparations,<sup>5</sup> particular care seems indicated to prevent perivenous spillage and intravenous thrombus formation.<sup>5,8</sup> No serious ill effects have been observed in any of our 50 cases. In one patient approximately 10 cc. of diodrast was erroneously injected into the perivenous and adjacent tissues. Moderate pain, tenderness, swelling, and discoloration were present for two days. No damage to the femoral vein was observed. The femoral vein could not be punctured in one obese, colored male. Novocaine injection at the puncture site before and after the diodrast injection masks the pain attendant on venipuncture and that following if some spillage occurs.

#### SUMMARY AND CONCLUSION

1. A technique for visualization of the inferior vena cava is presented.

2. The method is simple, safe, and may prove to be a very valuable diagnostic adjunct.

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# UREMIC EDEMA OF THE LUNGS

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**I**N AN investigation of the roentgenological appearances of the lungs in heart failure (total number not stated), Roubier and Plauchu (1934) separated out 4 cases which presented an unusual picture. Three showed fluffy shadows spreading out from both hilar regions leaving a clear zone at the apices, periphery and lowest portion of the bases. One showed a fine granularity of similar distribution. Clinically, there were no special pulmonary symptoms except slight cough and at postmortem the lungs were grossly edematous but free from infection. Since the edema was not fulminating, the authors described it as subacute. All suffered from hypertensive heart failure with uremia. For this reason the pulmonary condition has also been called "uremic" edema.

Further cases whose roentgenograms showed "uremic" edema of lungs have been reported by Klima and Rosegger (1936) (2, both fatal); Lelong and Bernard (1937) (1, recovered); Roubier (1938) (1, recovered); Rendich, Levy and Cove (1941) (6, 2 recovered); and Ivanitskaya (1943) (1, fatal). In the non-fatal cases the shadows disappeared in a matter of a few days as the patients improved clinically. Whereas Roubier attributed the clearing of the lungs to a fall in the blood urea, Rendich, Levy and Cove considered the edema to resolve with relief of the heart failure. In some the shadows were unilateral, usually on the right side. Physical signs of pulmonary edema were absent or minimal. The paucity of pathological description in these reports seems to make it important to record the pathological appearances which underlie this roentgenological picture and to discuss some possible clinical correlations.

## PATHOLOGICAL FINDINGS

The material is best presented by describing the appearances in the lungs in a

series of cases of which further details are given in the appendix. All were uremic and in hypertensive failure. Cases I and II showed a widespread fibrinous intra-alveolar exudate, Case III a predominantly albuminous exudate and Case IV a mixed picture. Case V was one of transitory pulmonary edema with recovery.

**CASE I.** F.D., a young man suffering from chronic glomerulonephritis with a blood urea of 300 mg. per 100 cc., blood pressure 210/160, intense dyspnea, cough but no sputum, showed on the roentgenogram a patchy obscuring of the middle and upper zones of the right lung; the right apex and periphery and the left hemithorax were clear. Five days later, dyspnea had increased, the blood urea had risen to 476 mg. and a further roentgenogram (Fig. 1) showed a similar obscuring of the left upper and middle zones sharply demarcated from a translucent strip at the apex and periphery, the right-sided opacities had spread farther toward the periphery, both bases were relatively clear. He died one week later, having been afebrile throughout.

At postmortem, there was a bilateral fibrinous pleurisy, more pronounced over the upper lobes. Both lungs were voluminous, firm, with exaggerated costal and vascular markings. The cut surfaces showed a lobar consolidation of the upper lobes and edema of the lower lobes. The upper lobes were rubbery in consistency and gelatinous, not quite so dense as a typical lobar pneumonia. This peculiar consolidation stopped abruptly about 1.5 cm. below the apex which was normally aerated. The central and upper portions of the lower lobes showed a similar gelatinous consolidation. The bases contained a moderate amount of edematous fluid. The hilar lymph nodes were enlarged. There was pus in some of the lower lobe bronchi.

Sections of the upper lobe show a widespread intra-alveolar fibrinous exudate (Fig. 5 and 6). Foamy septal cells are prominent both lining and lying free in the alveoli. The cellular reaction is somewhat sparse and is almost entirely mononuclear. The fibrin is arranged in clumped threads (violet with Weigert's stain, red with

Heidenhain's azo-carmin) some of which can be seen streaming through the pores of Kohn (Fig. 6). A number of the mononuclear cells are spindle shaped resembling young fibroblasts. This is associated with the development of argyrophil fibers among the fibrin threads. The alveolar capillaries are distended with red cells a few of which have escaped into the alveoli. The alveolar ducts stand out distended with air (Fig. 5) and lined by a thin hyaline membrane, giving positive staining reactions for fibrin, which appears to seal off the openings of their tributary alveoli. The interlobular septa are edematous. The bronchioles and alveoli are free from pus and organisms.

The ultimate unit of fibrinous consolidation appears to be the group of alveoli supplied by one alveolar duct. The distribution is haphazard not obviously related anatomically to the distribution of interlobular septa or larger vessels or bronchioles. In some places it is limited by the septa, in others it crosses over them, in others it stops short of them (Fig. 5). Normal as well as consolidated alveolar systems are present in sections of the central as well as other portions of upper lobe. The junction of



FIG. 1. Case I. September 23, 1943. Roentgenogram showing diffuse opacities in the upper and middle zones of both lung fields with a clear cut translucent zone in the apex and periphery on the left side.



FIG. 2. Case III. September 29, 1945. Roentgenogram showing widespread opacities in both lungs whose apices, extreme periphery and bases appear clear.

consolidated and aerated lung at the apex and periphery does not correspond with any septa or other interstitial structures. Sections of the base show congestion and packing of the alveoli with pigment-laden macrophages (carbon and hemosiderin granules). There are patches of hemorrhage, polymorphonuclears in some of the bronchi, but no pneumonic consolidation.

CASE II. H. R., a man suffering from malignant hypertension, admitted moribund with a blood urea of 238 mg., blood pressure 220/140, intense dyspnea, cough but no sputum and a normal temperature, showed on roentgen examination a widespread bilateral fluffy mottling in the lungs extending out from the hilar regions to the periphery leaving translucent zones at the apices and bases. His arterial oxygen saturation was 46 per cent rising to 78 per cent after fifteen minutes' administration of oxygen through a B.L.B. mask. The average normal figure is 95 per cent.

At postmortem, the left pleural space was dry, the right obliterated by old adhesions. Both lungs were voluminous and firm, there were a few patches of fibrinous pleurisy on the posterior aspect of the upper portion of the left lower lobe. The subpleural lymphatics were prominent. The cut surfaces of both lungs showed a widespread gelatinous consolidation which did not involve the extreme apices and bases.



FIG. 3. Case v. July 17, 1944. Roentgenogram showing bilateral opacities in the lung fields radiating out from the hilar regions.

Sections show intra-alveolar fibrinous exudate, mononuclear reaction, argyrophil fiber formation, distended capillaries and prominent alveolar ducts lined by a thin film of fibrin, as seen in the previous case. The distribution is equally irregular. There is no evidence of any bacterial infection and no arteritis. The connective tissue of the interlobular septa is edematous and contains scattered deposits of fibrin infiltrated with a few mononuclear cells.

CASE III. H. E., a woman suffering from malignant hypertension with a blood urea of 362 mg., blood pressure 300/150, breathlessness at rest, cough but no sputum and a normal temperature, showed on the roentgenogram (Fig. 2) large ill defined patches of increased density radiating out from both hilar regions, leaving a translucent zone in the apices, peripheral borders and bases.

At postmortem, each pleural sac contained a few cubic centimeters of clear fluid. The lungs were voluminous and heavy. There was no pleurisy, the subpleural lymphatics were prominent. The cut surfaces showed a mixed appearance. There was a widespread edema making the lungs appear like a sponge soaked in water, probably a terminal phenomenon. In addition, there were numerous patches of "solid" edema occupying the perihilar regions extending out to but not reaching the periphery. This part of the lung was somewhat

rubbery, gelatinous and exuded frothy fluid only on firm pressure, and floated in water.

Sections of the "solid" edematous lung show engorged capillaries, edematous interlobular septa and an albuminous intra-alveolar exudate. There are numerous red cells and a moderate number of mononuclears mixed with the deeply eosinophil albumin. In addition, scattered alveoli contain clumped fibrin threads and mononuclears, not related to the presence of free red cells. The areas of fibrinous exudate, though far less widespread, show a similar constitution to those seen in the previous two cases. Alveolar ducts distended with air are prominent. They are lined by a thin film of albumin. The distribution of the edema is irregular. Sections of the peripheral portions of lung show an intra-alveolar albuminous exudate which is only weakly eosinophil and fairly free from cells.

CASE IV. D. W. a boy suffering from chronic glomerulonephritis with a blood urea of 187 mg., blood pressure 215/160, and no signs of heart failure, showed clear lung fields in a roentgenogram. While in the hospital he developed signs of heart failure and his blood urea rose. A roentgenogram taken one month later, when he was breathless at rest and the blood urea was 407 mg., showed ill defined opaque areas in the middle zones of both lungs, extending

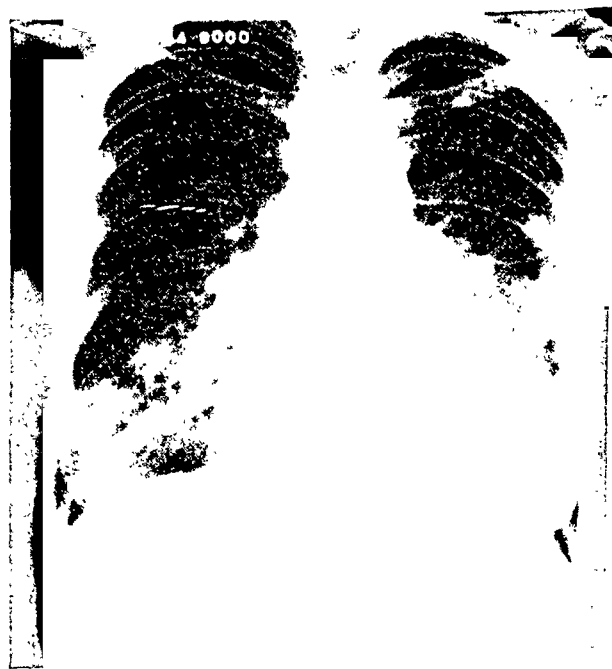


FIG. 4. Case v. July 25, 1944. Roentgenogram showing marked diminution in the lung opacities.

well out towards the axillae, leaving the apices and bases relatively clear. He died one week later having been afebrile throughout.

At postmortem, the pleural spaces were dry. The lungs were voluminous, not very heavy, free from pleurisy showing prominent subpleural lymphatics. The parenchyma was of a rubbery consistency and released a little frothy fluid only on firm pressure. Samples floated in water. The apices, anterior margins and basal fringes were emphysematous. Some basal bronchi were filled with thick yellow pus.

Sections of the lungs show a varied picture. There is a generalized capillary engorgement and edema of the interalveolar septa. Many alveoli contain an intensely eosinophil albuminous exudate, but the lung is better aerated than in previous cases. The intra-alveolar exudate contains mononuclear cells often pigmented and numerous red cells. Some alveoli are filled with septal cells. A number of alveolar ducts and alveoli contain clumped fibrin threads, not associated with red cells, occasionally covered by an endothelial-like layer of septal cells. Alveolar ducts distended with air and lined by a hyaline albuminous membrane are also present. A few contain small whorls of

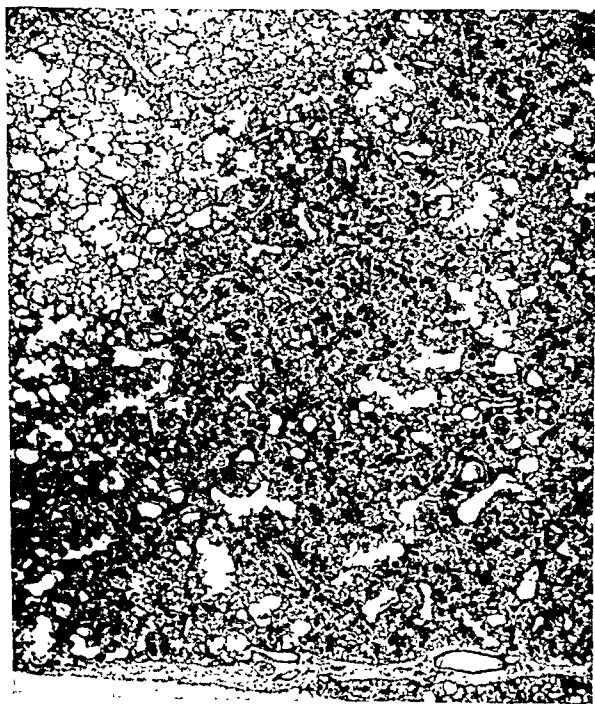


FIG. 5. Case 1. Photomicrograph of lung (stained by hematoxylin and eosin, magnification  $\times 7$ ) showing irregularly distributed consolidation and empty distended alveolar ducts.



FIG. 6. Case 1. Photomicrograph of lung (stained by hematoxylin and eosin, magnification  $\times 100$ ) showing intra-alveolar plugs of fibrin streaming through a pore of Kohn in the center, undergoing organization in the left lower part of the field.

young fibrous tissue (organized fibrin clumps) covered by a similar layer of flattened septal cells. The basal bronchiolitis has not yet developed into a bronchopneumonia.

CASE V. G. M., a young woman suffering from chronic glomerulonephritis was admitted with an acute onset of heart failure. Roentgen examination showed fluffy opacities in both lungs, more marked on the right side, radiating out from the hilar regions (Fig. 3). With rest in bed, the dyspnea disappeared and a roentgenogram taken one week later showed marked diminution in the lung opacities (Fig. 4). A roentgenogram taken four weeks previously had shown clear lung fields. There was no significant alteration in the blood urea (which averaged 265 mg.) before, during and after the episode of heart failure.

#### DISCUSSION

##### (a) Interpretation of Roentgenological and Pathological Findings.

*Roentgenological appearances:* The distribution rather than the nature of the fine or coarse mottling appears to be typical of



subacute pulmonary edema associated with uremia and hypertensive heart failure. The more familiar insidious edema of chronic heart failure uncomplicated by gross renal deficiency produces a loss of translucency most marked in the basal zones. The reason why roentgenological appearances of the lungs in acute fulminating pulmonary edema have seldom been recorded is that the patients are desperately ill and the diagnosis is hardly in doubt. Coe and Otell (1932) described the roentgenological picture in an attack of acute pulmonary edema in a man suffering from syphilitic aortic regurgitation. There were large patches of increased density radiating out from both hilar regions towards the periphery, a distribution similar to the subacute type. Zdansky (1929, 1933) and Werkenthin (1939) also recorded a few cases of pulmonary edema with similarly distributed shadows, but their case records show the patients to have been subacute clinically and suffering from kidney disease. Nessa and Rigler (1941) reported the appearances in 7 cases due to various causes: chronic nephritis, mitral stenosis, postoperative overloading with fluids, postoperative heart failure (2), diabetic coma and post-intracranial operation. In the chronic nephritis patient the edema was subacute clinically and showed the typical central mottling, clear periphery apices and bases. A lateral view confirmed the central distribution of the shadows. Most of the other cases showed mixed pictures including the appearance of confluent pneumonic consolidation involving one or more lobes. Survey of a number of roentgenograms in our own hospital records suggests that the distribution of the edema fluid as seen roentgenologically in uremic cardiac cases is similar to that in uncomplicated acute left ventricular failure, confirming the findings of Coe and Otell.

*Clinical findings:* Our own cases confirm the subacute nature of the pulmonary edema pointed out by Roubier and Plauchu. None of the patients was febrile. The intensity of the roentgen changes in the lungs

was out of proportion to the signs in the chest which were minimal, perhaps a result of the central distribution of the edema. Most showed the features of left heart failure, i.e. recent attacks of paroxysmal nocturnal dyspnea, a normal or moderately raised jugular venous pressure and very little if any peripheral edema. Anemia was not an essential feature.

*Biochemical findings:* The blood urea levels were high; 238 mg. or more in this series. However, in Roubier and Plauchu's series the lowest blood urea was 135 mg. while in Rendich, Levy and Cove's series one had a blood urea as low as 90 mg. The average in these two latter series was 250 mg. There was no obvious correlation of the onset of edema with any one of the uremic biochemical findings such as acidosis or hypoproteinemia.

*Pathological findings:* The most significant changes seen in the lungs of all our cases were the naked eye appearance of widespread "solid edema" and the microscopic evidence of a greater or lesser degree of a fibrinous intra-alveolar exudate. Gelatinous, somewhat rubbery lung which yields frothy fluid only on firm pressure, described as "solid edema," has been familiar to morbid anatomists for many years. It has most often been found situated in the lower lobes in cases of heart failure.

Microscopy usually shows an intense congestion and a strongly eosinophilic (protein rich) intra-alveolar exudate. The widespread fibrinous intra-alveolar exudate seen in Cases I and II was most striking and represents an alveolar change reminiscent of uremic pericarditis. In Case III, however, pericarditis was present but the lungs showed an albuminous edema. Albuminous rather than fibrinous pulmonary edema is more frequently recorded in uremia, though Ivanitskaya described one case of the fibrinous type; he called it "uremic pneumonia." Case IV, and to a certain extent Case III, showed fibrinous patches in addition to the predominating albuminous exudate. More instances must therefore be studied before it will be

possible to decide whether or not there is a fibrinous element in all and what are the relative frequencies of the predominantly fibrinous or albuminous types. In no case was there any evidence in the lungs of arteritis. The clinical and pathological findings ruled out pneumonia. In transitory cases such as Case v, the exudate is most likely albuminous. Fibrin would hardly be reabsorbed in a few days in the absence of polymorphonuclears, nor do the findings of organization in Cases I and II suggest the presence of abundant fibrinolysins in uremic lungs.

#### (b) *Mechanisms.*

*Mechanism:* Case v demonstrated clearly the essential role of heart failure in the development of the pulmonary edema. The blood urea level stayed constant, the lung changes appeared with the onset of failure and resolved with the relief of failure. Rendich, Levy and Cove failed to find roentgenological evidence of pulmonary edema in 50 random uremic patients who were free from signs of heart failure.

Since the experiments of Cohnheim and Welch (1878) the onset of fulminating pulmonary edema in acute left ventricular failure is usually considered to result from a sudden great rise of pressure in the pulmonary capillaries. In uremia, congested alveolar capillaries may be so altered that they leak coagulable fluid. Thus, a widespread edema would be produced by only a moderate rise in pulmonary capillary pressure. It might be expected that the more profound the uremia, the less severe need the heart failure be to produce edema, but proof of this would be difficult to obtain. The coagulated exudate interfered with arterial oxygen saturation in Case II which may induce the vicious circle mechanism in left ventricular failure described by Drinker and Warren (1943).

*Distribution of the edema:* It is indeed difficult to understand why the apices, extreme bases and often periphery of the lungs escape. In Case IV, the peripheral portions showed marked emphysema but

this was a sequel to the edematous consolidation rather than a cause. The findings in general imply localized differences in degree of pulmonary engorgement and possibly in efficiency of lymphatic drainage. But too little is known of the mechanism of vasomotor control of the lung vasculature to advance the argument further.

#### (c) *Comparison with Rheumatic Pneumonia.*

The lungs in Cases I, II and IV showed lesions identical with those described in rheumatic pneumonia by Hadfield (1938) who found the condition to result from an initial fibrinous alveolitis leading to a mononuclear reaction and eventual organization. He described hyaline membranes lining the alveolar ducts in the deposition of which dyspnea was considered to play an important part. Carditis was always present, and often a fibrinous pericarditis and pleurisy. Since the same initial lesion is present in the "uremic" lung it is not surprising that a similar ultimate picture is produced. The small intra-alveolar whorls of young fibrous tissue seen in Case IV, are similar to Mason's (1937) "bourgeons conjonctifs" described in rheumatic pneumonia. Epstein and Greenspan (1941) concluded that the pulmonary picture of rheumatic pneumonia was a characteristic, though not specific, result of damage to the capillaries, with increased capillary permeability. In addition, they looked for these changes in 59 control cases (other forms of heart disease) and found the characteristic picture in only one case, who died in uremia of chronic glomerulonephritis with hypertensive cardiac disease and mild failure! In both rheumatic fever and in uremic hypertensive failure, therefore, a similar type of damage to pulmonary capillaries may occur with a characteristic lung pathology.

*Incidence:* Cases of uremic edema of the lungs have only been found when suitable patients have been investigated in spite of the absence or paucity of pulmonary signs. The roentgenograms of Cases I, II, III and v were taken chiefly from the point of view

of the heart rather than the lungs. In Case IV, the possibility of "uremic" edema was considered and a further roentgenogram taken in spite of the earlier normal one. There is no doubt that serial roentgenograms of uremic patients in hypertensive failure will bring to light many cases of subacute pulmonary edema. The lungs are so often overwhelmed by a superimposed terminal acute edema that the underlying lesion is easily missed at postmortem, and unless one is aware of its nature the fibrinous edema may be dismissed as an organizing pneumonia. Finally, the transitory cases appear to be rare, and Rendich, Levy and Cove pointed out that the presence of these pulmonary changes is a poor prognostic sign.

#### SUMMARY AND CONCLUSION

1. A proportion of uremic hypertensive patients with left ventricular failure develop a subacute pulmonary edema which may be transitory. Roentgenograms show massive centrally distributed shadows in the lungs in spite of minimal local signs and symptoms apart from dyspnea.

2. In fatal cases, the lungs show a widespread "solid edema" due to a fibrinous or an albuminous intra-alveolar exudate. This is associated with a mononuclear cell reaction and organization, and hyaline membranes lining the alveolar ducts.

3. The exudate is considered to result from a combination of a rise in pulmonary capillary pressure due to left ventricular failure and an alteration in capillary permeability resulting from uremia.

4. Though characteristic, the lesion is not specific and is seen in other conditions of heart failure associated with capillary damage, such as rheumatic fever.

#### APPENDIX: CASE RECORDS

The blood urea, chlorides, potassium, calcium and phosphates are expressed in milligrams per 100 cc.

CASE I. F. D. (Dr. E. G. L. Bywaters), male, aged twenty-seven; uremia, hypertension and heart failure. Wasting, headaches and vomiting for nine months. Two weeks' cough and pain in chest, no sputum. One week paroxysmal nocturnal dyspnea,

orthopnea and swelling of the ankles. On admission (September 15, 1943): blood pressure 210/160, considerable respiratory distress, pulse 130 per minute, temperature normal, papilledema and a few retinal exudates. Heart enlarged to left, fine rales and impaired breath sounds both bases and right midzone. Blood urea 300 mg. Chest roentgenogram (September 18, 1943) described above. The patient became increasingly distressed and dyspneic and developed dullness to percussion over both midzones. Blood urea (September 23, 1943) 476 mg. Chest roentgenogram (September 23, 1943) (Fig. 1) described above. The blood urea continued to rise, reaching 520 mg. on September 29. The results of additional investigations were hemoglobin 68 per cent (10.6 grams per 100 cc.), red blood cells 3,700,000 per c. mm., white blood cells 10,000 per c. mm., polymorphonuclears 70 per cent, total plasma proteins 5.1 per cent, CO<sub>2</sub> combining power of plasma 45.3 cc., plasma chlorides (as NaCl) 600, urea clearance 6.2 per cent; albumin (400 mg. per 100 cc.), granular casts and red cells in the urine whose output was reduced and specific gravity fixed at 1.010. The patient died on September 30, 1943, having been afebrile throughout.

*Postmortem* (2786), twenty-four hours after death. Gross left ventricular hypertrophy (heart 570 grams), no pericarditis, slight "horse-shoe" deformity of kidneys which were finely granular and reduced in size and on section show chronic glomerulonephritis, congested liver and spleen, mucosal petechiae in stomach.

CASE II. H. R. (Dr. M. Nellen), male, aged forty-eight, uremia, hypertension and heart failure. Admitted on May 28, 1945, moribund and died after three days. Five weeks' breathlessness, few days' coughing up blood-streaked sputum. Blood pressure 220/140, jugular venous pressure not raised, temperature normal, pulse 110 per minute, respirations 42 per minute, cough, no sputum while in hospital, widespread fine rales in chest, no peripheral edema. The arterial oxygen saturation and roentgen findings are given above. Hemoglobin 51 per cent (8.00 grams per 100 cc.), white blood cells 15,000 per c. mm. Blood urea (postmortem) 238. mg.

*Postmortem* (3358), eighteen hours after death. Left ventricular hypertrophy, heart weight 460 grams, no pericarditis, shrunken granular kidneys (170 grams together) whose sections show a long standing ischemic nephritis upon which are superimposed the changes seen in malignant hypertension (glomerular fibrinoid necroses, intimal fibrocellular hyperplasia of the interlobular arteries).

CASE III. H. E. (Dr. M. Nellen), female, aged fifty-two, uremia, hypertension and heart failure. Admitted September 17, 1945, died September 28, 1945. Occipital headaches and failing vision for one month. Blood pressure 300/150, jugular venous pressure 6 cm. above the sternal angle, pulse 90 per minute, temperature normal, fundal exudates and

early papilledema, breathless at rest, cough but no sputum, fine and medium rales widespread over both sides of chest. The blood urea was 208 mg. on September 20, 1945, rising to 362 mg. on September 24. She developed the signs of pericardial friction on September 25. Chest roentgenogram (September 27) (Fig. 4) described above. Additional investigations, serum cholesterol 209, total serum proteins 6.9 grams per 100 cc., CO<sub>2</sub> combining power 59.5 cc.

*Postmortem* (3437), twenty-four hours after death. Gross left ventricular hypertrophy, heart weighed 545 grams, acute fibrinous pericarditis showing a scanty mononuclear reaction on section, granular kidneys weighing 230 grams together whose sections show malignant hypertensive changes superimposed upon ischemic nephritis, congested liver and spleen.

CASE IV. D. W. (Dr. S. P. V. Sherlock), male, aged thirteen, chronic glomerulonephritis, uremia, hypertension and heart failure. Admitted November 27, 1945, died January 8, 1946. Three weeks' anorexia, headache and vomiting. Blood pressure 215/160, jugular venous pressure 1 cm. above the sternal angle, blood urea 187 mg., bilateral papilledema, urea clearance 14 per cent. Chest roentgenogram (December 1, 1945): enlarged heart, clear lung fields. Onset of heart failure middle of December, breathlessness, rising jugular venous pressure, enlarged liver. The blood urea had also been rising: 218 mg. on December 3, 1945, 407 mg. on January 1, 1946. Chest roentgenogram (January 1), described above. There were widespread fine rales in the chest, cough but no sputum. Cheyne-Stokes respiration and drowsiness set in during his last week of life. Additional investigations: hemoglobin 79 per cent (12.3 grams per 100 cc.), falling to 62 per cent (9.67 grams per 100 cc.), plasma phosphate 5.0 rising to 11.9, total plasma proteins 6.6 grams per 100 cc. falling to 5.5, plasma CO<sub>2</sub> combining power 48.3 cc. falling to 32.5, serum cholesterol 380 falling to 222, plasma chlorides as NaCl 516, serum calcium 8.6, plasma potassium 19.4 rising to 23, albumin (215 mg.) and granular casts in the urine.

*Postmortem* (3540), twenty-four hours after death, showed a wasted boy weighing 4 stones. Gross left ventricular hypertrophy, heart weighed 300 grams, no pericarditis, kidneys 110 grams together, moderately shrunken, finely granular, showing a longstanding chronic glomerulonephritis on section, congested liver and spleen.

CASE V. G. M. (Dr. E. P. S. Schafer), female, aged twenty-seven, eleven years' history of chronic glomerulonephritis. First admitted in 1935 with two years' history of albuminuria and edema; blood pressure 160/95, blood urea 33.8, Van Slyke urea clearance 26.5 per cent. Readmitted in 1941 suffering from severe headaches; blood pressure 200/110, blood urea 72, urea clearance 21 per cent. Further admission in 1942, blood pressure 215/135, blood urea 116, urea clearance 16 per cent. Admitted again June 10,

1944, with history of one week's persistent vomiting. This soon stopped on a copious fluid intake. Blood pressure 160/110, blood urea 252, hemoglobin 61 per cent (9.5 grams per 100 cc.), jugular venous pressure not raised, no clinical evidence of heart failure, chest roentgenogram (June 15, 1944), no pulmonary lesion. She went home symptom free on June 24, 1944, but did not rest and after one week became increasingly breathless and began to suffer from attacks of paroxysmal nocturnal dyspnea. Readmitted July 16, 1944, blood pressure 180/130, pulse 110 per minute, jugular venous pressure 2 cm. above sternal angle, blood urea 268, respiration rate 30 per minute, temperature normal, cough but no sputum, a few rales at left base, a few retinal exudates, no papilledema. Chest roentgenogram (Fig. 3) described above. With rest in bed, dyspnea disappeared completely. The blood urea remained high, 273 mg. on July 24, 1944, and a chest roentgenogram (July 25, 1944) (Fig. 4) now showed marked diminution in the lung opacities. The results of additional investigations were: hemoglobin 42.5 per cent (6.6 grams per 100 cc.), red blood cells 2,500,000 per c. mm., white blood cells 6,000 per c. mm., polymorphonuclears 75 per cent, total plasma proteins 5.9 grams per 100 cc. (albumin 4.3, globulin 1.6 grams per 100 cc.), plasma chlorides (as NaCl) 582, CO<sub>2</sub> combining power of plasma 46.3 cc., serum cholesterol 220, moderate albuminuria. The patient went home on August 1, 1944, with a much improved exercise tolerance; she died at home some months later.

I am grateful to Prof. J. McMichael and his colleagues of the Department of Medicine for their co-operation and to Drs. J. Duncan White and E. J. E. Topham for their advice on the interpretation of the roentgenograms. I thank Mr. E. V. Wilmott, A.R.-P.S., who prepared all the photographs and Mr. J. R. Baker, A.I.M.L.T., and Mr. J. G. Griffin, A.I.M.-L.T., who prepared the sections.

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# INFANTILE CORTICAL HYPEROSTOSES\*

## CASE REPORT

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THIS case is reported because of its apparent rarity and the unusual syndrome presented. It seems, however, to fit into the condition called "infantile cortical hyperostoses" by Caffey.<sup>1</sup> He published a report of 4 cases during the period of our study of this case. It would appear from a study of this case and those of Caffey that we are dealing with a specific syndrome. We may, therefore, hope for some future clarification when the pathology and etiology are no longer idiopathic.

### CASE REPORT

The patient, a white male, aged three months when admitted for the present illness, was born at Frankford Hospital of a primipara (aged thirty-four) by cesarean section. The mother was a potential eclamptic and after two days of intermittent labor, cesarean section was decided upon.

The baby weighed 7 pounds at birth. Examination

on the second day of life revealed an unusually large, square-shaped head, with a marked occipital protuberance. There was a moderate degree of hypospadias. The child appeared to lack vigor and was detained at the hospital for fourteen days.

Events at home for the next two months were not significant.

At three months the child was admitted to the hospital because of irritability, persistent crying and fever. Five days before admission, the child developed a fever, became very irritable and refused food. Examination was negative except for an injected left ear drum. Under appropriate therapy the ear showed marked improvement. However, the crying became worse, the temperature remained elevated and continued hospitalization was decided upon.

Physical examination revealed a well nourished child. Movement associated with the examination produced immediate and prolonged crying. The skin was hot and dry but of

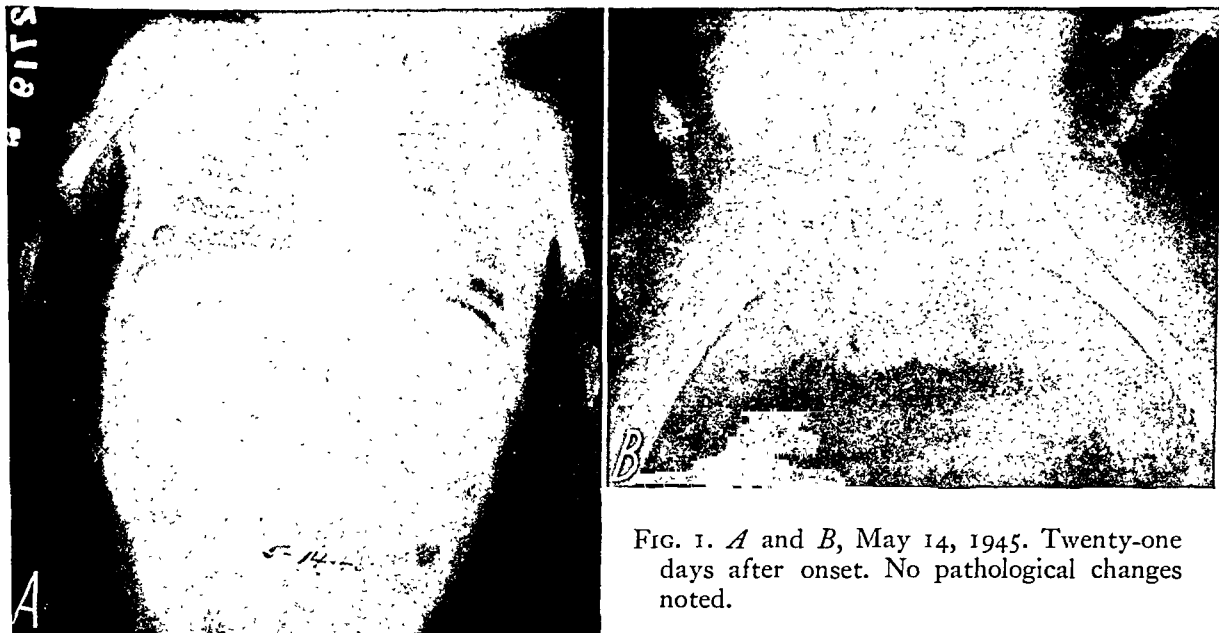


FIG. 1. *A* and *B*, May 14, 1945. Twenty-one days after onset. No pathological changes noted.

\* Presented before the Philadelphia Roentgen Ray Society, January 3, 1946.

<sup>1</sup> Caffey, J., and Silverman, W. A. Infantile cortical hyperostoses: preliminary report on new syndrome. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 1-16.



FIG. 2. *A* and *B*, June 5, 1945. First recorded roentgenographic evidence of pathological change.

normal tone and texture. Except for the injected left ear drum and a mild hypospadias, the physical examination was otherwise negative. A moderate leukocytosis (largely polymorphonuclear) was present. Our impression at this time was an acute otitis media.

Penicillin therapy was instituted but after five days the child was worse. Roentgen examination of the mastoid area was negative. Examination of the ears revealed nothing. The baby began to perspire profusely about the forehead, otherwise all the findings remained constant. At this time a skeletal and chest roentgen survey was entirely negative.

Surgical consultation was next sought and a spinal tap was suggested in view of the negative studies. This revealed an elevated pressure of 350 mm. which was verified by a repeated tap the next day. Spinal fluid studies presented nothing abnormal. The temperature remained at 101 to 103° F. and the child was acutely ill.

Neurologic consultation elicited a suggestion that an epidural abscess was a possibility. The following day some weakness of the right arm was noted for the first time, and the possibility of a subdural or epidural abscess spreading from the left ear was suggested. Re-examination

of the mastoids was again negative. No changes in the spinal fluid were noted.

At this time the child presented a sustained fever, profuse clammy sweating, irritability on the slightest motion, leukocytosis and increasing weakness of the right arm. After twenty-one days of hospitalization, we were no nearer solution of our problem than on the day of admission.

Ten days later, one month after admission, a slight swelling of the right arm, shoulder and scapular area was noted. This swelling rapidly increased and became acutely tender. Roentgen examination now revealed changes in the shaft of the right humerus, the right scapula, ribs, the shaft of the left femur and mandible. Within a day or two a widespread maculo-papulo-pustular eruption appeared with a further rise in temperature. The child showed no weight gain and was doing poorly. Ten days after the bone changes were observed, the temperature began to slowly subside and the rash to disappear.

Biopsy of the scapular area revealed inflammatory infiltration with periosteal hyperplasia. Following this surgical procedure, there was a marked rise in temperature, the skin eruption recurred and the child appeared to be in bad condition.

All therapy seemed of no avail, but within a week the temperature began again to return to normal. Serial roentgen studies showed a slow



FIG. 3. June 11, 1945.

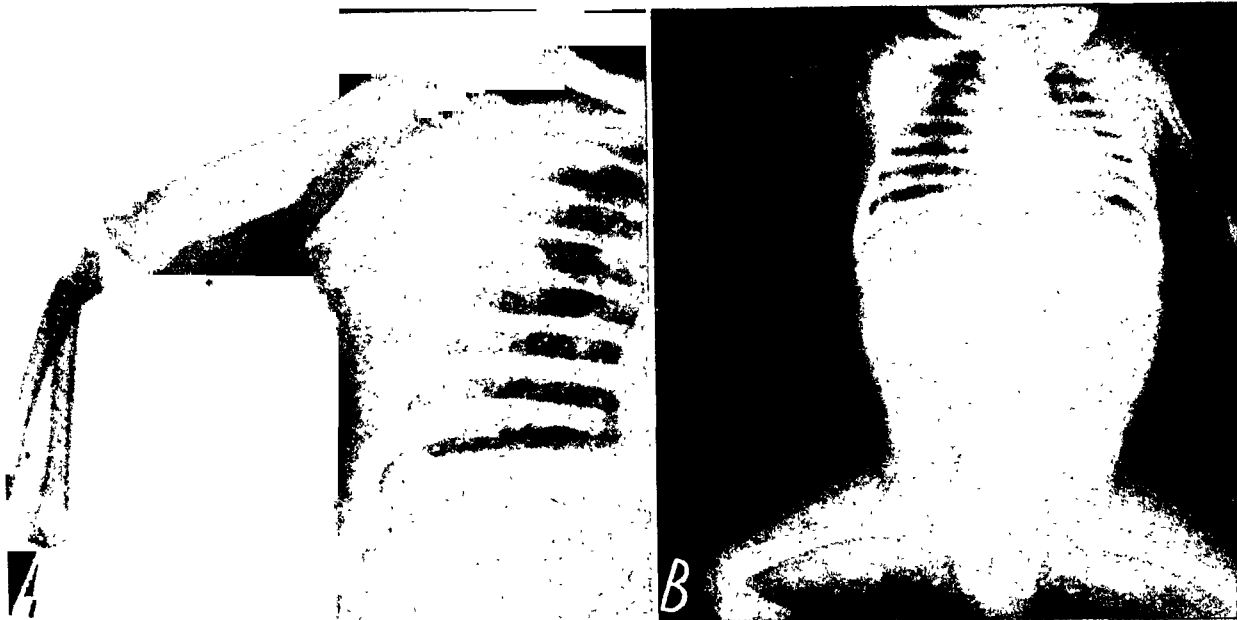


FIG. 4. *A*, June 27, 1945. Maximum point of hyperostosis. *B*, June 27, 1945. *C*, June 27, 1945. Shows mandibular involvement.



FIG. 5. July 3, 1945. Regression.



FIG. 6. July 15, 1945. Further regression.



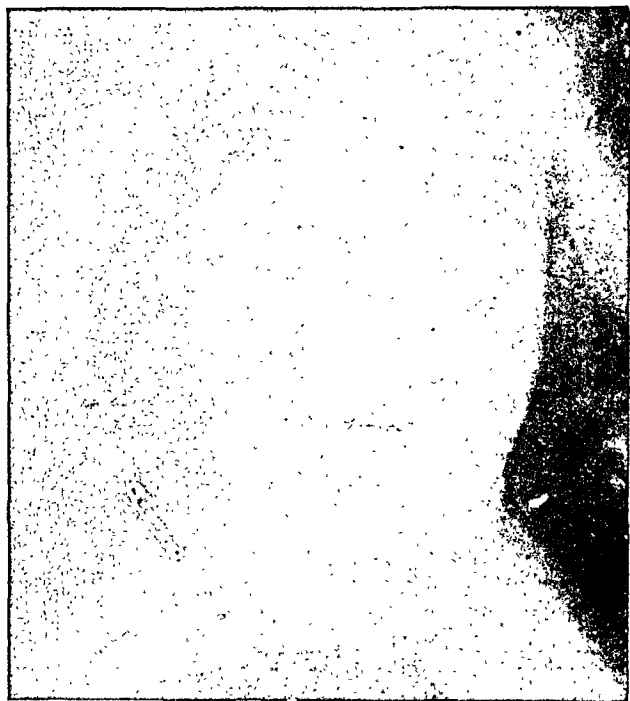


FIG. 7. September 4, 1945. Regression almost completed.

but continuous regression of the bone changes.

After four months' hospitalization but with still a rectal temperature of  $101^{\circ}$  F. the child was discharged to home care. At discharge most of the bone lesions had disappeared and there was free motion in the right arm.

*Laboratory Findings.* The leukocyte count ranged from 24,500 to 9,000 with a marked rise in lymphocytes to 64 per cent as the count returned to normal. The erythrocyte count was 3.6 to 4.8 million. Hemoglobin 9 to 11 gm.



FIG. 8. December 5, 1945. Seven months after onset. Complete return to normal.

Blood and spinal fluid Wassermann reactions were negative. Culture of the biopsy material was negative. Micro-sedimentation rate 13 mm. per hour. Spinal fluid: sugar, 64 mg., chloride 675-690 mg., proteins 10-20 mg. Serum calcium 11-16 mg., phosphorus 6-10 mg. Urinalyses were negative.

Since the child's return home seven months from onset of illness, the weight and temperature have returned to normal. He still had clammy sweats with one recurrent episode of the skin eruption. This child is now two years old and apparently normal.

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# THE ETIOLOGY OF INFANTILE CORTICAL HYPEROSTOSES

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WITH the description, by Caffey,<sup>1</sup> in this JOURNAL of an entity which he denominated "infantile cortical hyperostoses," roentgenologists were enabled to add a very clearly delineated affection of bone to their classification of diseases involving the osseous system. Caffey's cases were most carefully studied, described with the utmost thoroughness, and left no detail of the clinical history, physical findings, or laboratory results a matter for subsequent enquiry.

At the time of Caffey's publication, we had in our file a case displaying all of the cardinal findings listed in his paper. We had felt, justifiably enough at the time, that there was no niche in the classification of bone diseases into which our findings fitted: we acknowledge a debt to Caffey in providing one.

We are publishing our case because the findings seem quite typical, and because our case appears quite clearly to demonstrate an infectious origin; we believe also that in reviewing Caffey's cases, evidence of an infectious origin is not lacking in any of them.

## REPORT OF CASE

Baby Wm., aged three months, was admitted to West Suburban Hospital on October 5, 1944, with the following complaints: fever, irritability, disuse of the right arm, evident pain on handling, and swellings along the outer margins of each foot, these swellings being particularly tender.

He had been a full-term infant, delivered spontaneously after an uneventful pregnancy. The Wassermann reactions of both parents were negative. The Wassermann reaction on cord blood negative. Birth weight, 7 pounds; no abnormalities noted.

He had been partially breast fed for two months; feedings had been supervised, as had his vitamin intake.

Ten days before his admission to the hospital, he was vaccinated for smallpox; his reaction was rather sharp to this procedure, with evidence of fever (reported by mother), irritability, and the appearance of the bilateral lower extremity swellings.

Physical examination disclosed a slight generalized edema; the infant appeared acutely ill, and he was also stuporous. His temperature was 101.4° F. rectally. His right arm showed no active movement (vaccination had been on the left).

Over the distal half of each fifth metatarsal there was a smooth, hard, tender, fusiform swelling; the overlying skin was shiny but not hot nor red.

There was noted some bulging of the anterior fontanelle; the sagittal suture and the posterior fontanelle were open. The temporoparietal suture was closed. The skull bones were thin and soft; some craniotabes was noted.

*Laboratory Findings.* Urinalysis, negative; leukocyte count, 12,700, with 68 per cent polymorphonuclears, 32 per cent lymphocytes; erythrocyte count, 3,373,000; hemoglobin, 62 per cent. Wassermann and Kahn reactions negative on baby, mother and father.

Spinal fluid: pressure increased (not measured), 45 cc. easily obtained; clear, 3 cells per cu. mm. (lymphocytes); globulin, negative by Pandy test; sugar, 96; Wassermann negative.

The temperature rose to 102° F. but became normal on October 7; the strength of the right arm increased rapidly; edema gradually disappeared. The hard, shiny swellings over both metatarsals persisted.

On October 14, a recrudescence of the constitutional symptoms became apparent; prostration was rather marked, both arms appearing flaccid; the temperature rose to 100.4° F., but on the other days during this exacerbation, remained below 100° F.

More blood studies revealed a developing anemia (erythrocyte count 3,900,000, with a drop in polymorphonuclears (31 per cent) and a rise in lymphocytes (58 per cent). Other laboratory studies revealed: blood calcium 12.5;



FIG. 1. A bilateral osteoperiostitis involving the fifth metatarsals; there is some involvement of the first metatarsals. The soft tissue swellings seen over each fifth metatarsal were very tender; this is one of the findings emphasized by Caffey.

blood phosphorus 3.7; blood ascorbic acid 0.32 mg.; blood alkaline phosphatase 87 (normal 14); blood urobilin negative.

Recovery was gradual; four and one-half months from the onset of the illness, the patient appeared in rather good condition, could pull up standing, walk with aid, and displayed normal mental responses.

*Röntgen Findings.* The first lesion to appear in the course of this febrile illness was a bilateral ossifying periostitis involving the fifth metatarsals. Just why the process should have been symmetrical and bilateral we are unable to conjecture, though we must admit, in this connection, that it is idle to attempt to account for the selectivity of bacteria for certain anatomical sites—as to why the organism of rheumatic fever selects the mitral valve, or why the *Treponema pallidum* chooses the aorta, and so forth.

The metatarsal process became flagrant, after which it gradually subsided, leaving in its wake a not inconsiderable cortical thickening. It will be noted in Figure 1 that the first metatarsals were not altogether free of involvement, though here the condition seems to have more



FIG. 2. The process shown in Figure 1, at a later date. The osteoperiostitis of the fifth metatarsals has become a much more extensive one. Beneath, the cortex of the bone can be distinctly seen, and shows a relatively slight participation in the inflammatory process; the periostitis component is by far the more important one.

the character of a simple osteitis.

The association of periostitis with cortical thickening is not a remarkable finding, nor characteristic of any particular entity; any infectious process involving either structure soon extends to involve the other, if it continues beyond the initial stage.

excludes syphilis, and the history plus the roentgen findings clearly excludes any of the deficiency diseases; nor do the lesions suggest a blood dyscrasia, of which there was, incidentally, no indication in the hematologic studies.

The approach to some of these questions



FIG. 3. A very florid periostitic involvement of both clavicles. This was interpreted at another hospital as bilateral healing fracture. There is some involvement of both scapulae; and some, rather shadowy, of both humeri.

The findings relative to the clavicles illustrate Caffey's observation that the mid-shaft area is involved in long bones, with the ends of the bones usually spared; there is evidence of osseous condensation and periosteal involvement in both scapulae, and the upper humeri have not escaped.

Roentgenograms of the skull and mandible were negative, though on physical examination thinning of the skull and increased intracranial pressure were evident; another roentgenogram, unfortunately not included here, shows an irregularity at the end of one ulna appearing morphologically very much like a luetic osteochondritis; the latter condition was not, however, seriously considered in view of the negative serology.

As to etiology, the above clinical history

may at times become unnecessarily involved; in which connection one of us remembers something said to him once, when a student, in a surgical clinic:

"You can divide all surgery into four groups," said Dr. Davenport in his County Hospital Clinic, "... congenital, traumatic, inflammatory, and neoplastic. . . ." In something the same manner, a radiologist may reason, and not be too far from the truth, that a lesion partaking of the characteristics of osteoperiostitis may be divided into certain parent, generic groups; for example, inflammatory, neoplastic, metabolic, and traumatic. In the case reported here, it should not be too difficult to exclude neoplastic, metabolic and traumatic.

As mentioned above, the illness began following a smallpox vaccination; it was certainly febrile in character; the bony lesions occurred in the course of the febrile attack, and showed some evidence of resolution, even tending toward a restitutio ad integrum as the illness subsided; and therefore, might it not be more logical to attribute an osteoperiostitis developing against such a background as infectious in character, possibly partaking of the type of an osteomyelitis variolosa (which used to find a more frequent place in textbooks than it does today, for a very obvious reason), than to search elsewhere for an etiologic factor?

It is true that the findings are not those which have been most often described under the heading osteomyelitis variolosa, but here some latitude must be allowed for the consideration that vaccinia is an illness somewhat different from variola, though closely allied to it.

In reviewing Caffey's cases, it would appear that the only ones in which a febrile course was not described were those not under observation during the early part of their illness; and even those, after hospital admission, did give evidence of fever. This suggests that, in Caffey's cases, serious consideration cannot be denied infection as an etiologic factor, and that infantile cortical hyperostoses represent an infectious osteoperiostitis.

#### SUMMARY

A case of osteoperiostitis, occurring during the course of a febrile illness, is described; the illness was initiated, apparently, by a vaccination reaction.

The roentgen finding developed here appear to agree closely with Caffey's infantile cortical hyperostoses; and in view of the fact that a febrile course characterized all of Caffey's cases in which adequate observation was made available, we believe that

infantile cortical hyperostoses represent a form of infectious osteoperiostitis.

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## MESENTERIC THROMBOSIS\*

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THE writer desires to report a fourth case of proved mesenteric thrombosis with roentgenologic findings similar to the 3 cases described by Rendich and Harrington.<sup>1</sup> The authors observed localized distention of the intestines down to the region of the splenic flexure, simulating a mechanical obstruction. The limitation of the distention was that of the superior mesenteric vessels and their anastomoses. The abrupt demarcation of distended bowel near the region of the splenic flexure in their 3 proved cases suggested that the possible diagnoses of thrombosis of the superior mesenteric vessels be among those considered when the plain roentgenogram of the abdomen gave the impression of an obstructing lesion near the splenic flexure, and especially if a subsequent barium enema revealed no obstructing lesion.

It is accepted that not every case of mesenteric vascular occlusion shows distended bowel, but the incidence of distention is high in the clinical records.<sup>1</sup>

In the case described herewith, the patient had a history of a previously proved peptic ulcer and was admitted for an acute condition of the abdomen, with the clinical diagnosis of either a mechanical obstruction or a paralytic ileus due to a perforated ulcer. In interpreting the plain roentgenogram of the abdomen, the roentgenologist noted the colon distended to the region of the splenic flexure and stated an opinion that mesenteric thrombosis was also to be included in the differential diagnosis. Subsequent operation disclosed hemorrhagic infarction of the small intestine with a venous thrombosis of the superior mesenteric vessels.

### CASE REPORT

H. B., aged forty-eight, a policeman, was admitted to Kings County Hospital, Brooklyn,

New York, on January 13, 1946. His chief complaint was abdominal cramps. The present illness began on January 1, with pain across the entire chest lasting nine days. This was followed by lower abdominal cramps that increased in severity. Abdominal distention began January 10. No bowel movements for five days. Passed no gas but had a bloody discharge from the rectum. No vomiting was present.

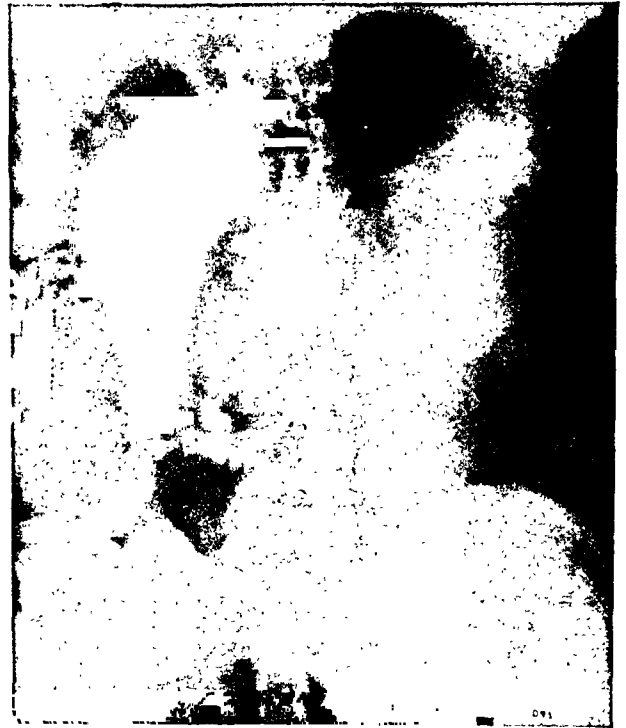


FIG. 1. Distention of the colon down to the region of the splenic flexure, simulating a mechanical obstruction. The demarcation corresponds to the limit of distribution of the superior mesenteric vessels and their anastomoses. Mesenteric thrombosis (venous) was found.

The past history disclosed an appendectomy in 1919. A duodenal ulcer was reported on roentgen examination a number of years before.

The physical examination showed a white male in extreme abdominal distress, writhing about in bed, groaning and pressing on his abdomen. The examination was generally negative except for the abdomen which was

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distended and tympanitic except in the left lower quadrant. Liver dullness was decreased.

The temperature was 99° F.; pulse 120; blood pressure 180/100; respirations were 28. The urine showed 4 plus acetone. The leukocyte count was 10,200; red blood cell count was 6.5 million. The Wassermann reaction was negative.

The operation was performed with spinal anesthesia and curare. Serosanguineous fluid was present in the peritoneal cavity. The small intestine was twisted upon itself and gangrenous as far as the eye could see. Because of the patient's very poor condition, the most severely involved segment of intestine was exteriorized and the patient was returned to the ward. The postoperative course was stormy. Exteriorization of more intestine showed progressive thrombosis (venous). Subsequently 5 feet of small intestine were resected. The patient died on January 18.

*Postmortem.* Anatomical diagnosis: Thrombosis of the mesenteric veins with infarction of the jejunum and ileum. Edema and hemorrhage of the upper mesentery. Fibrous adhesions between the anterior parietal peritoneum and the cecum. Firm mass palpable in the duodenal cap (duodenal ulcer).

*Microscopic* (Segment of small intestine). The structures are separated by hemorrhage and edematous fluid. Some vessels contain thrombi. Their walls are infiltrated by polymorphonuclear leukocytes in the submucosa. In the relatively intact portions of the wall, all layers of the intestine are edematous and contain recent hemorrhagic focal collections of polymorphonuclear leukocytes and lymphocytes. In these regions the blood vessels of the submucosa show infiltration of their walls. In the superficial necrotic portions of the mucosa are occasional clumps of bacteria. Diagnosis: hemorrhagic infarction of small intestine; venous thrombosis of small intestine.

#### SUMMARY

A proved case of mesenteric thrombosis is described with roentgenologic findings similar to those in the three cases previously reported by Rendich and Harrington.<sup>1</sup> The plain roentgenogram of the abdomen showed bowel distended down to the region of the splenic flexure, simulating a mechanical obstruction, and corresponding

to the limit of distribution of the superior mesenteric vessels and their anastomoses.

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1. RENDICH, R. A., and HARRINGTON, L. A. Roentgenologic observations in mesenteric thrombosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 317-322.

#### ADDENDUM

Three additional proved cases of mesenteric thrombosis with roentgen findings of diagnostic interest similar to the Case I described above have been observed since the paper was submitted for publication. The case reports follow:

**CASE II.** E.T., aged forty-five, a factory worker was admitted to Kings County Hospital on October 8, 1945, and was discharged on January 17, 1946. His chief complaint was pain in the abdomen. The present illness began the night before admission with pain in the right upper and right lower quadrants of the abdomen. The pain had a sudden onset, was sharp and constant. There was vomitus slightly bloody in character. Bowel movements have been bloody.

The past history disclosed joint pains in childhood.

The physical examination revealed a well nourished male in acute pain. The heart was enlarged to the left. The heart beat and pulse were very irregular. There was a systolic mitral murmur transmitted to the apex.

The abdomen was soft, with rebound tenderness in both lower quadrants. The clinical diagnosis of auricular fibrillation with possible acute mesenteric embolism was made.

*Roentgen Findings.* There was slight distention of the right half of the colon (Fig. 2).

*Operation.* Considerable bloody fluid was found in the peritoneal cavity; edema and congestion of distal 7 feet of small bowel with areas of necrosis about 3 feet from the ileocecal valve. Eighteen inches of ileum were found to be gangrenous due to an arterial block (emboli). End to end anastomosis was done after removal of 18 inches of small bowel.

There was eventual complete recovery.

**CASE III.** J.S., aged fifty-three, was admitted

to Kings County Hospital on April 4, 1947, and died two days later.

The chief complaint was crampy abdominal pain, accompanied by vomiting and diarrhea.

The present illness began about eleven days before admission when the patient ate what he considered "bad meat." Following this he vomited everything ingested and had many watery stools streaked with bright red blood. This illness lasted a week. On the night prior to admission, severe crampy abdominal pain and many loose watery stools occurred.



FIG. 2. The roentgenogram shows slight distention of the right half of the colon down to the region of the splenic flexure.

The past history disclosed that the patient had tropical diarrhea in the Philippines two years before.

Physical examination revealed a well nourished white patient who was intermittently doubling up with abdominal pain. There was slight abdominal tenderness to deep palpation.

FIG. 4. The roentgenogram shows distention of the right half of the colon down to the region of the splenic flexure; small bowel also dilated. Possibilities considered were either mechanical obstruction

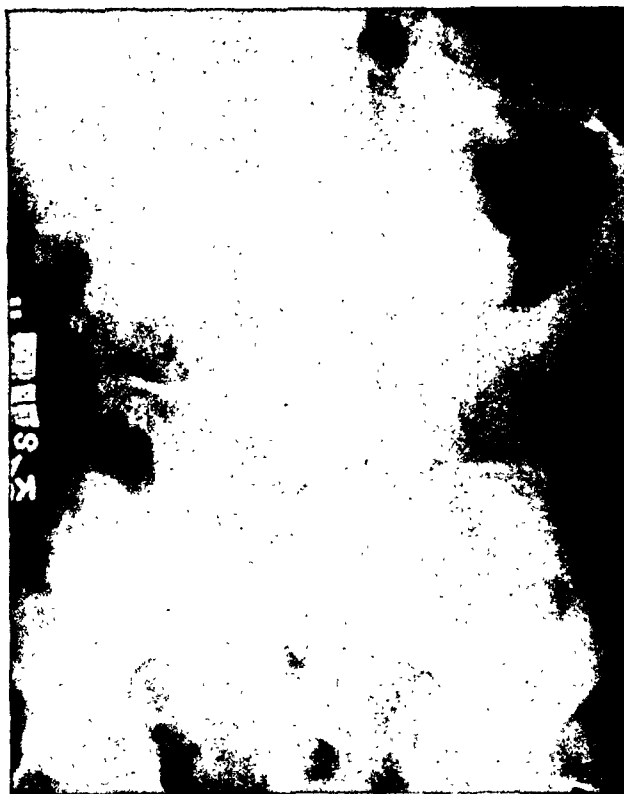


FIG. 3. There is gas in the right half of the colon and a loop of small bowel. Note localized distention of colon near the splenic flexure.



or mesenteric thrombosis. Operation disclosed marked gangrene of small bowel and cecum due to mesenteric thrombosis.



Normal peristaltic sounds were heard. The morning after admission moderate distention of the abdomen and generalized tenderness were found.

Roentgen examination (plain film of the abdomen) revealed gas in the right half of the colon with some distention near the splenic flexure. A loop of small intestine was dilated. The senior resident on roentgenology (Dr. Irving Rose) was impressed by the localized distention in the left half of the transverse colon and considered a diagnosis of mesenteric thrombosis to be tenable (Fig. 3). Operation disclosed 400 cc. of dark foul fluid in the abdomen and distended bowel with purplish-blue portions of small bowel and colon in its proximal half. A thrombus 1.3 cm. in size was found in the superior mesenteric artery at its origin from the aorta. The patient died twelve hours after the operation. Autopsy findings included: (1) specific gastroenteritis, and (2) thrombotic occlusion of the superior mesenteric artery.

CASE IV. M.DeB., middle-aged female, was

admitted to Kings County Hospital on September 7, 1947, and died on September 20. She was well until eight weeks before admission when she developed nausea, abdominal cramps and diarrhea. The patient was not in acute distress. The clinical considerations included duodenal ulcer and possible neoplasm of the gastrointestinal tract.

On September 17, 1947, the patient suddenly developed severe abdominal pain, generalized in character, with marked abdominal distention, rigidity and tympanites. Vomiting occurred. A plain roentgenogram of the abdomen disclosed distention of the right half of the colon down to the splenic flexure, with some gas in the small bowel. Roentgen interpretation was that of either a mechanical obstruction in the colon or mesenteric thrombosis (Fig. 4).

Operation revealed gangrene of the small bowel from the jejunum to the terminal ileum, and also gangrene of the cecum. Operative diagnosis was mesenteric thrombosis. Resection could not be performed. Death occurred in three days.



# LIPOSARCOMA OF THE CAPSULE OF THE LEFT KIDNEY COMPLICATING NEPHROLITHIASIS AND PYONEPHROSIS\*

## CASE REPORT WITH AUTOPSY

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THE conditions predisposing to renal lithiasis were described by Flocks<sup>3</sup> as follows:

1. Diseases producing prolonged immobilization of the body.
  - a. Fractures of the spine or extremities associated with prolonged immobilization of large bones.
  - b. Chronic osteomyelitis.
  - c. Chronic arthritis or other bone joint diseases producing immobilization of large portions of the skeleton.
  - d. Neurologic damage as a result of trauma or disease producing prolonged immobilization.
  - e. Chronic visceral disease requiring prolonged recumbency.
2. Changes in the urinary organs.
  - a. Congenital anomalies associated with stasis.
  - b. Acquired obstruction—stricture of urethra and the like.
  - c. Paralysis of urinary passageway.
  - d. Introduction of infection into urinary tract.
  - e. Foreign body in urinary passageway.
3. Endocrinopathies.
  - a. Hyperparathyroidism.
  - b. Hyperthyroidism.
  - c. Hyperpituitary disease.
4. Focus of infection elsewhere in the body.
5. Vitamin deficiency or excess.
  - a. Vitamin A deficiency.
  - b. Vitamin D excess.
6. Metabolic abnormalities.
  - a. Idiopathic hypercalcinuria.
  - b. Changes in colloids.

In a study of the records of 375 patients with proved diagnosis of urolithiasis Baer<sup>1</sup> states that an increase in the amount of urinary crystalloids is a contributing factor to the formation of some kidney and ureteral stones. He also concludes in the same report that the use of alkalis in therapy may produce upper urinary tract stones in certain individuals.

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## CASE REPORT

J. S., male, white, aged sixty-seven, was admitted to the Cumberland Hospital on March 28, 1945.

The patient stated that he was unable to work during the last four to five weeks prior to admission because of weakness, lack of appetite and loss of weight.

A review of the cardiovascular, respiratory,



FIG. 1. Roentgenogram showing the narrow portion of the body of the stomach due to pressure from an extrinsic mass.

gastrointestinal and genitourinary systems was negative.

Past and family histories were non-contributory.



FIG. 2. Intravenous urogram revealing a hydronephrosis on the right side and extensive nephrolithiasis on the left side.

Physical examination revealed a poorly developed, poorly nourished, elderly man in no acute distress. The chest was barrel shaped with diminished breath sounds throughout. The heart was enlarged to the left and there was a localized aortic systolic murmur. Abdominal examination revealed a bilateral hernia. The liver and spleen were not palpable. There was a stony hard, irregular and non-tender mass in the left flank which gave a peculiar grating sensation to the palpating fingers. Rectal examination revealed a moderately enlarged, non-tender smooth prostate. Neurological examination was negative. The temperature was 100.8° F., pulse 90, respirations 20, and the blood pressure 90 systolic and 65 diastolic.

The clinical impressions were: (1) hydronephrosis; (2) nephrolithiasis; (3) malignancy of the left kidney; (4) malignancy of the colon.

*Laboratory Data.* Blood Wassermann was negative. The red blood cell count ranged from 2,000,000 to 2,500,000 with a hemoglobin from 32 to 40 per cent. The white blood cell count varied from 12,500 to 16,000 with 67 to 74 per cent polymorphonuclears, 10 to 21 per cent young forms and 11 to 15 per cent lymphocytes. Urine was negative except for a trace of albu-

min. The blood urea nitrogen was 27 to 30 mg. per 100 cc. on different occasions. The blood sugar was 69 mg. per 100 cc. Gastric analysis showed no free hydrochloric acid. A flat plate of the abdomen showed an agglomeration of 150 to 300 triangular-shaped opacities in the region of the left kidney. A roentgen study of the gastrointestinal tract was negative except for narrowing of part of the body of the stomach caused by pressure from an extrinsic mass (Fig. 1).

Intravenous and retrograde urograms revealed a hydronephrosis on the right side and extensive nephrolithiasis on the left side (Fig. 2).

Roentgenographic study of the chest showed an irregularity of the right diaphragmatic leaf due to old adhesions.

Cystoscopy and catheterization of the kidneys resulted in clear urine from the right kidney and cloudy urine which contained albumin and 3 to 4 leukocytes per high power field from the left kidney.

The patient ran a low grade fever from 101° to 102° F. Despite three blood transfusions, his condition became progressively and rapidly worse. He died on May 4, 1945, about five weeks after admission to the hospital.

Postmortem examination disclosed a liposarcoma of the capsule of the left kidney complicating nephrolithiasis and pyonephrosis. The neoplastic mass invaded and displaced the adjacent kidney and calices. The calices were also filled with 815 faceted, yellow-gray calculi, each 1 cm. in diameter. Several staghorn calculi were also embedded in the parenchyma. There was malignant spread to the serous linings, lymph nodes, lung, and liver with marked hydrothorax.

Chemical analysis of some of the stones revealed magnesium ammonium phosphate and calcium carbonate.

*Comment.* This case is of extreme interest. The patient was admitted to the hospital with no complaints referable to the urinary tract despite 815 stones found in the left kidney. This proves the silent characteristic of some renal lithiasis as stated by Flocks.<sup>2</sup>

The cause of such an unusual number of stones is questionable. We know that there was pyonephrosis of the same kidney. Was this infection a cause or the result of the

nephrolithiasis? Flocks<sup>3</sup> claims that with the onset of infection there is much more rapid growth of stones.

Was there any relation of the liposarcoma of the renal capsule, which invaded the kidney and calices, to the renal lithiasis?

#### SUMMARY

1. A case of silent nephrolithiasis is recorded because of the unusually large number of stones, i.e. 815 stones, each of which measured 1 cm. in diameter. The stones were faceted, which is rare in renal lithiasis. To our knowledge, such a number of stones in one kidney has not been reported in the literature.

2. In addition to the renal lithiasis, there was pyonephrosis and liposarcoma which extended from the renal capsule into the kidney parenchyma and calices.

3. No answer could be given in this case as to the causative relation between the liposarcoma, pyonephrosis and such an extensive nephrolithiasis.

4. In retrospect, the physical findings of an irregular, stony hard mass with a peculiar grating sensation under the palpating fingers should make one aware of the possibility of a bag-like structure or organ containing numerous stones.

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# ROENTGEN STUDY OF THE STERNOCLAVICULAR REGION

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## INTRODUCTION

CERTAIN regions of the body have not been accorded by roentgenologists generally the attention they merit. This is due to the fact that these areas cannot be visualized clearly with routine roentgen techniques either because they are obscured by adjacent structures or their anatomic locations make them relatively inaccessible. For example, the temporomandibular regions and the floor of the skull are difficult to examine and in consequence are infrequently studied by many roentgenologists. Similarly, the sternoclavicular joints have long been one of the "neglected regions" of the body. In sagittal and oblique projections, the sternum and adjacent portions of the clavicles are obscured by the overlying densities of the spine, ribs, mediastinal structures, lungs and soft tissues of the chest walls. In lateral views, the sternoclavicular joints are at a considerable distance from the film and are covered by overlying shadows so that it is practically impossible to obtain roentgenograms of diagnostic value. Planigraphy obviates these difficulties to a great extent but at present is not available in most roentgen departments. However, techniques have been developed which make it possible to greatly minimize the poor detail and lack of clarity of outline caused by overlying structures and the distance of the sternoclavicular joints from the film. With these methods, clear delineation of the sternum and the proximal ends of the clavicles can be obtained, making it possible to visualize lesions which would ordinarily not be demonstrable. The roentgenologist willing to acquire the necessary skill can obtain very gratifying results and will be enabled to make diagnoses which would not otherwise be possible. The purpose of this communication is to review briefly the anatomy

and pathology of the sternoclavicular regions and describe the roentgen methods of visualizing these joints.

## ANATOMY

The sternoclavicular articulation is classified as an arthrodial diarthrosis and is composed of the superolateral margin of the manubrium sterni and the medial end of the clavicle. The articular facet of the sternum is situated on the upper and outer border of the manubrium, lies in a plane slightly posterior to the sternal notch, and is distinctly smaller than the clavicular facet with which it articulates. The inner end of the clavicle is roughly triangular; its most prominent angle is directed posteriorly and slightly downward. The superior surface of the first costal cartilage adjacent to the sternum is also included to some extent in the articulation. The joint surfaces of the sternoclavicular articulation are covered mainly by fibrocartilage. The capsule is thin along its inferior portion, the remainder being well developed. The epiphysis and the epiphyseal line of the clavicle are included within the capsule. The joint is held in position by the forward tilt of the manubrium, the anterior and posterior sternoclavicular ligaments, the interclavicular and costoclavicular ligaments, and the superior surface of the first costal cartilage. The range of motion of the joint is normally very slight. The bony arch formed by the clavicle and scapula articulates directly with the axial skeleton at only one point, the sternoclavicular joint, which is of particular importance with reference to certain deformities of this articulation which will be discussed below.

The clavicle is one of the first bones to ossify, the middle of the bone showing beginning ossification as early as the seventh

week of fetal life. At the sternal end of the clavicle, there develops an epiphysis which remains cartilaginous until the sixteenth to eighteenth year, at which time a bony epiphyseal nucleus becomes visible (see Fig. 4); this epiphysis fuses at the twentieth to twenty-fifth year. The manubrium of the sternum usually ossifies at about the sixth month of fetal life. During childhood, the segments of the sternum are separated by narrow cartilaginous bands; these fuse in later life. In some instances, small ossicles may be present in close relation to the sternoclavicular joint, adjacent to the superior margin of the joint. Articular connections may or may not be present between the anterior end of the first rib and the clavicle. Calcification of the first costal cartilage usually lies below and well away from the sternoclavicular joint.

#### ROENTGEN METHODS

Roentgen study of the sternoclavicular joint requires special care. Except by the aid of planigraphy, there is no way of eliminating the overlying shadows of the vertebral column, the mediastinal structures, the lung tissues and the ribs. With the patient supine, the joint is in the closest possible approximation to the film, affording the greatest sharpness of definition and a minimum of distortion. However, this



FIG. 1. The sternoclavicular region, posteroanterior view, with short target-film distance technique.



FIG. 2. Oblique view of the sternoclavicular region.

position frequently cannot be assumed by the patient because of spinal or chest deformities, large breasts, or pain and swelling due to trauma, infection or neoplasm. Oblique and lateral views result in distortion and magnification. Each case must be studied individually and roentgenograms made in various projections as indicated. The following are the methods of study which we have found useful in obtaining the most satisfactory roentgenograms of this region.

1. *Posteroanterior Views.* (a) Conventional technique. The head must not be turned; the chin rests on the table. The hands are at the sides with the palms up. The central ray is directed through the fourth dorsal vertebra if both joints are to be viewed simultaneously. When each side is being studied separately, a small diaphragm is inserted and the focus is directly over the joint. A target-film distance of 36 to 40 inches is used with the Potter-Bucky diaphragm and a rotating anode, small focal spot tube. With the above technique, the joints are usually hazy and obscured by overlying structures.

(b) Short target-film distance technique. The clarity of detail may be greatly increased by the use of a very short film-target distance which tends to magnify and throw out of focus the shadows of the spine, mediastinal structures and posterior



FIG. 3. Lateral projection of the sternoclavicular joint.

ribs. A very short cone or diaphragm which limits the size of the field to about 8 to 10 inches is inserted below the tube and placed as close to the patient as the tube carriage permits. With shock-proof tubes, the cone may be brought into contact with the patient. Non-shock-proof equipment should be given the minimum clearance required for safety. The sternoclavicular joints are considerably magnified, but the definition and clarity of outline in properly executed roentgenograms of this type is very striking (see Fig. 1).

2. *Anteroposterior Views:* This position is less satisfactory because the joint is at a considerable distance from the film. However, much valuable information may be obtained from this view. The sternum itself is poorly visualized. The medial por-

tions of the clavicles may be well seen, however.

3. *Oblique Projections:* (a) With angulation of the tube. The patient is positioned as for the posteroanterior view and the tube rotated through an arc of about  $20^\circ$ , the central ray being directed through the joint to the film. With the flat type of Potter-Bucky diaphragm, the grid lines are projected on the film. (b) With the patient rotated. The patient lies prone with the side of the body opposite the joint to be studied raised about  $45^\circ$  from the table. The central ray is directed through the elevated shoulder about 10 cm. lateral to the fourth dorsal vertebra. Both sides should be studied for comparison (see Fig. 3).

4. *Lateral Projection:* (a) With the central ray directed at right angles to the joint. The patient stands or lies with the shoulders drawn back and the arms at the side. The two joints are superimposed, this view therefore being of limited value. (b) With the central ray directed obliquely. This projection, described by Kurzbaue,<sup>8</sup> is of great value and is described by him as follows: "The patient is positioned laterally recumbent, the affected side lowermost, on the roentgenographic table, with a frontal plane through the sternoclavicular articulations coinciding with the long axis of the

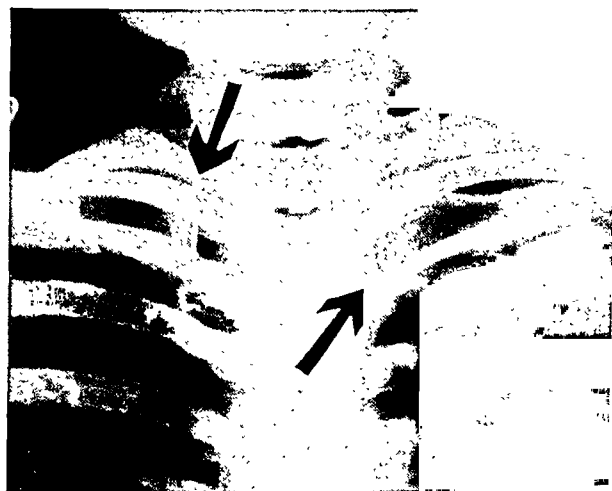


FIG. 4. The sternoclavicular joints in a female, aged twenty. The epiphyses at the proximal ends of the clavicles are indicated by the arrows.

Potter-Bucky diaphragm. The arm nearer the film is extended fully cephalad, the hand grasping the end of the table. The uppermost arm is pulled caudad along the lateral chest wall using slight force . . . The principal ray is directed caudad at an angle of 15 degrees from its perpendicular position through the lower articulation, using a 3 inch localizing cone . . . The center of an 8 by 10 inch cassette is aligned to coincide with the principal ray. The patient is instructed to arrest breathing on maximum inspiration." (See Fig. 4.)

By following these procedures, sharp and clear roentgenograms of the sternoclavicular region can be obtained. Not all of the projections described are necessary in every instance, the roentgenologist choosing the combination of views best suited to the particular case. The studies are most satisfactorily carried out in the recumbent positions. If the patient is unable to lie down because of pain, deformities, etc., erect views may be used in part or entirely.

#### FRACTURES AND DISLOCATIONS

Fractures of the sternum and clavicle are frequently very difficult to demonstrate and may easily be overlooked. The pain and swelling consequent upon the trauma not infrequently make accurate positioning and immobilization of the patient impossible even in the upright position. With roentgenograms of good quality, a



FIG. 5. Comminuted fracture of the proximal end of the clavicle.



FIG. 6. Cleidocranial dysostosis. The patient was a female, aged sixty-five. The incomplete development of the clavicles is well demonstrated. Changes in the skull and pelvis were present also, as described in the text. There was abnormal mobility of the shoulders.

fracture should be demonstrable in one or more projections (see Fig 5). At times, the examination made soon after the injury may not show any abnormality, while a study made at a later date reveals a fracture. This possibility should be borne in mind and the examination repeated after an interval of a few days or weeks. In no instance should a final diagnosis be made unless the roentgenograms are technically perfect in every detail. In suspected dislocations, it must be borne in mind that the lesion may apparently reduce itself with the patient recumbent. Roentgen study in cases of possible luxation of the sternoclavicular joint should include views in the upright position with the arm hanging unsupported at the side.

#### CONGENITAL ANOMALIES

There are two congenital anomalies worthy of note in this region: (1) cleidocranial dysostosis, and (2) a notch-like defect in the inferior aspect of the proximal end of the clavicle.

(1) Cleidocranial dysostosis is usually seen in association with anomalies of the skull and pelvis. The condition is hereditary. Roentgen study affords a method of positive diagnosis, although there are clinical evidences which may suggest the diagnosis. Clinically, there is marked prom-





FIG. 7. Congenital anomaly of the clavicle. There is an irregular, semicircular defect at the inferior aspect of the proximal end of each clavicle (see arrows) referred to as the rhomboid fossa.

inence of the frontal and parietal eminences with apparent disproportion between the bones of the head and those of the face, the head being large and misshapen. The teeth are delayed in development, show faulty implantation, and defects in the enamel. The shoulders are abnormally mobile and the muscles of the neck are thick. The anomaly usually occurs in other members of the same family. Roentgen study of the skull reveals incomplete ossification of the skull, large fontanelles and widening of the suture lines. The base in the sagittal projection appears smaller than normal, causing the squamous portion of the temporal bone to lie in a diagonal plane and the mastoids to be projected more anteriorly than usual. The various bones of the skull fail to unite with the formation of accessory centers of ossification, creating the impression of numerous wormian bones. The bones of the skull are out of proportion to those of the face, the latter being smaller than normal. The clavicles are in some instances absent; in others, the shafts are partially or entirely unformed (see Fig. 6). The extremities of the clavicles are more apt to be present since they arise from secondary centers in cartilage. Various deformities of the spine with spina bifida, fusions, and other anomalies occur.

There may also be defects in the bones of the pelvis and malformations of the joints of the fingers.

2 A congenital anomaly of the clavicle has been described by Schwartz<sup>18</sup> and others.<sup>13</sup> This consists of irregular, semicircular indentations along the inferior aspects of the proximal ends of the clavicles. The areas are small or large, usually asymmetrical, and the bone in this region appears normal (see Fig. 7). This anomaly is apparently of no clinical significance and should not be confused with a pathologic process.

#### NEOPLASMS, OSTEITIS AND ARTHRITIS

The diagnostic problems occurring in the region of the sternoclavicular joint are greatly complicated by the difficulties of clearly visualizing the changes. The roentgen manifestations are the same as in other studies made in the above described projections, the process may be demonstrated and correctly diagnosed. Arthritis of the sternoclavicular joint is rare, probably because of the limited range of mobility of the joint, its relative freedom from trauma,

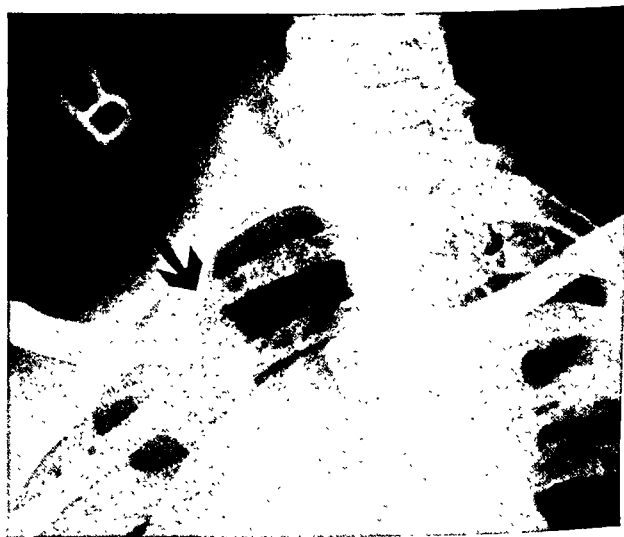


FIG. 8. Enchondroma of the proximal end of the right clavicle (arrow). Patient is a female, aged forty-six. For several months she had noted a swelling in the sternoclavicular region. Roentgen study revealed expansion and increased radiance with absence of trabeculae in the proximal end of the right clavicle; there were no evidences of periosteal proliferation, new bone production or break in the cortex.

and the fact that it is not a weight-bearing joint.

#### PROMINENCE OR SWELLING IN THE REGION OF THE STERNOCLAVICULAR JOINT

We have seen a small group of patients, 11 in number, whose chief complaint was that of swelling or prominence in the region of the sternal end of the clavicle and in whom probable neoplasm was the clinical diagnosis. These patients have been mainly women who were particularly concerned because a "lump" was noticeable when wearing a low-neck dress. In these cases, no lesion was demonstrable in the bones or joints. It was noted on the roentgenograms, however, that the affected sternoclavicular joint and the clavicle were at a higher level than the contralateral side, particularly with the patient in the erect position (see

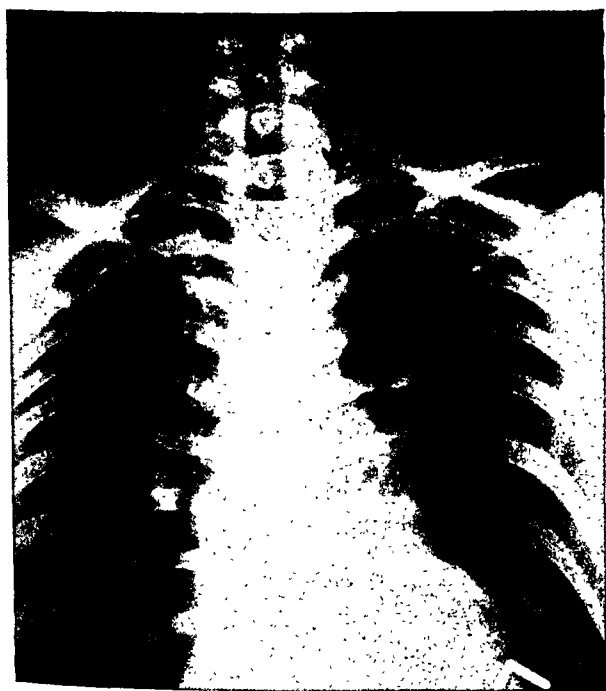


FIG. 9. Prominence of the sternal end of the left clavicle (arrow) secondary to scoliosis in the cervicodorsal region. The medial aspect of the left clavicle lies at a distinctly higher level than the right. The patient had noted prominence in the left sternoclavicular region and had consulted her physician as she feared a malignant lesion. The doctor made a diagnosis of "probable neoplasm." Roentgen demonstration of the cause of the condition relieved her fears.



FIG. 10. Metastatic carcinoma, osteoblastic type, secondary to carcinoma of the prostate. Roentgenogram made with very short target-film distance shows the sternoclavicular regions with sharp definition and clarity of detail.

Fig. 9). Examination of the spine revealed in every instance a scoliosis of the dorsal spine. The scoliosis resulted in elevation of the shoulder and tilting of the clavicle, manifesting itself to the patient as a prominence in the region of the sternoclavicular joint. Correction of the scoliosis usually brought about disappearance of the swelling and deformity. In those instances in which the scoliosis could not be eliminated, the reassurance resulting from the explanation of the cause of the condition was of great importance to both the patient and the referring physician.

#### SUMMARY

The sternoclavicular joints are difficult to visualize by routine roentgen methods. Special techniques to aid in clear delineation of these joints are described. These include sagittal projections with very short target-film distance, oblique views and lateral views.

Fractures may be difficult to demonstrate because pain and swelling make accurate positioning and immobilization impossible. The possibility of delayed appearance of fractures must be borne in mind and repeated examinations made at intervals of a few days or weeks.

The congenital anomalies are described and an additional case of cleidocranial dysostosis is reproduced (see Fig 6).

Prominence or swelling in the region of the sternoclavicular joint is a not uncommon complaint and usually leads to a clinical diagnosis of a probable neoplasm. This deformity may be produced by a scoliosis which elevates the shoulder and tilts the clavicle. Roentgen demonstration of the true nature of the deformity is of great importance to both patient and physician.

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# SOME ASPECTS OF THE RESULTS OF RADIATION TREATMENT OF CARCINOMA OF THE CERVIX UTERI

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AT THE University of Michigan, the full scale radiation attack on carcinoma of the cervix uteri began with the year 1932. With few exceptions, since that year, all such cases which have been treated have been irradiated. The present report presents some aspects of the results of such therapy in the cases seen from 1932 to 1943 inclusive.

As shown in Table I, 1,318 patients with carcinoma of the cervix were seen in the twelve year period. Of these, 71 were patients referred to our institution for only advice regarding therapy and received treatment elsewhere; such treatment as was given did not necessarily follow our recommendation and was neither under our supervision nor our control. Twenty-two patients were treated by total hysterectomy; the lesions in these patients were extremely small: the so-called "academic" carcinoma, intraepithelial carcinoma, etc. (our clinical Group I); these cases arise from a planned alternation of panhysterectomy and irradiation in the treatment of the cases of clinical Group I. Subtracting the "Consultation only" and the "Hysterectomy" groups, 1,225 cases are left.

TABLE I

Total number of patients seen 1932-1943	1318
Consultation only	71
Hysterectomy	22
Number of patients on which "absolute" survival percentage calculated	1225

The results which are reported in this paper are "absolute" survival percentages and are based on these 1,225 patients. The "Consultation only" group is excluded because it does not represent the experience of our institution. The "Hysterectomy" group is excluded because our concern is

with those patients who were at least potential candidates for radiation therapy.

For various reasons, 95 of the 1,225 patients were not irradiated, leaving 1,130 patients who received radiation treatment. Among these patients are included those whose radiation treatment was incomplete; any patient who received any radiation regardless of the quantity is included. Because of this and because the percentage of untreated patients is so low (less than 8 per cent) the results calculated on a "relative" basis are only slightly higher than the "absolute" ones and are not presented.

*Classification of Anatomical Extent of the Neoplasm.* Since 1932 an essentially constant scheme of classifying the anatomical extent of involvement has been employed. Each category of the classification has been termed "Clinical Group" but this has the same meaning as the term "Stage" which is usually used.

Clinical Group I. Very early carcinoma of the cervix: the so-called "academic" carcinoma; the intraepithelial lesion; the carcinoma of limited extent arising in cervical polyps, etc. In general this group consists of the early, very limited, often unrecognizable clinically, but histopathologically proved carcinomas of the cervix. There is no extension beyond the cervix.

Clinical Group II. Any carcinoma of the cervix which is still confined to the cervix (no parametrial thickening or vaginal extension) except the Clinical Group I cases.

Clinical Group III. Carcinoma of the cervix with questionable extension into parametrial tissues or vagina. The cervical lesion may be small or large. The characteristic feature of this group is that the evidence of extension beyond the cervix is questionable.

Clinical Group IVa. Carcinoma of the

cervix presenting objective evidence of extension beyond the cervix such as parametrial or vaginal wall invasion; the extension may be unilateral or bilateral but has not reached the stage of fixation.

Clinical Group ivb. Carcinoma of the cervix with extension to the extent of fixation of the parametrial and intrapelvic involvement; the fixation may be unilateral or bilateral.

Clinical Group ivc. Carcinoma of the cervix presenting regional or remote metastases and/or neoplastic fistulous formation.

For one reason or another, an occasional case escaped precise classification and is carried as "Unclassified." In every instance these are far-advanced cases.

*Histopathological Grading.* The degree of differentiation of the neoplasm has been classified arbitrarily into four grades. Grade 1 represents a well differentiated lesion and Grade 4 a very poorly differentiated tumor. Grades 2 and 3 are of intermediate degrees of de-differentiation, Grade 3 being more anaplastic than Grade 2. In the biopsy specimens not infrequently several grades of de-differentiation have been present in which case the tumor was graded according to the most anaplastic area. A histopathological diagnosis was made in practically every patient.

*Irradiation Technique.* Since 1932, the irradiation technique has consisted of a combination of external roentgen irradiation which was given first followed by intracavitary (vaginal and uterine) radium irradiation. Details of each of the two types of irradiation have varied somewhat in the twelve years under consideration. In respect to roentgen therapy, 200,000 volt radiation filtered by 0.5 mm. of copper and 1.0 mm. of aluminum (half-value layer of 0.9 mm. of copper) was used at a distance of 50 cm. (minute output varying from 42 to 50 r as measured in air) throughout the twelve years. Until July 1, 1936, roentgen radiation was administered according to a modified "saturation" routine in which each of two anterior and two posterior pelvic fields were irradiated at one sitting

(angling the beam of radiation so as to cross-fire the cervix) with a fraction of an "erythema" dose (varying from 160 to 260 r). The irradiation was given at intervals of from three to five days until skin reaction developed; the total dose per field varied from about 1,600 to 2,200 r as measured in air. The radium application followed within a few days after the completion of this series. From two and a half to as much as four to five months later, a second series of roentgen treatments was given; in many cases a third series and in some cases even a fourth was given after like intervals. As a rule each successive series attained a decreasing total dose.

Beginning July 1, 1936, the roentgen technique was altered to treating each of two fields per day, rotating through two anterior and two posterior pelvic fields. The fields were approximately 12 by 15 cm. in size with a midline separation of 2 cm.; the beam was directed normal to the frontal plane of the pelvis. Treatments were given daily exclusive of Sundays and 200 r as measured in air was given to each field. The total dose per field as a rule was 2,000 or 2,200 r although some very thin patients received only 1,800 r. Some of the larger individuals were given a dose in excess of 2,200 r. The radium application likewise was made within a few days of the completion of the roentgen treatment. After this no additional routine roentgen therapy was given; only in the case of recurrence or metastases was further treatment of this type used.

Throughout, the radium technique has remained essentially that of a single large dose given in a short time but with quite a few variations in details. Until January 1, 1938, filtration of 1.5 mm. of platinum was used. The most common arrangement consisted of a tandem tube of two chambers and two separate vaginal sources. The tandem tube was inserted into the uterus so that one chamber occupied the cervical canal, the other the uterine canal. The tandem was covered with non-metallic rubber. The vaginal applicators (platinum tubes) were usually fixed vertically in the

lateral portions of a thick felt pad saturated with paraffin and the entire unit was packed against the cervix so that the radium tubes came to lie in or near the lateral vaginal fornices. Sometimes the vaginal applicators were placed in a colpostat. Beginning February, 1936, the colpostat and paraffin felt pad were discarded and the tubes were held in place in a sponge rubber mass cut to fit the dimensions of the vagina.

The most frequent distribution of the radium was 80 mg. in the cervical part of the tandem, 50 mg. in the upper chamber and 50 mg. in each vaginal applicator. Many times variations according to the following formulae were used: 50-50-50-50; 70-50-60-60; 70-50-50-50; 80-60-60-60; 70-40-40-40. With the 80-50-50-50 arrangement, the time of application was usually twenty-four hours (5,520 mg-hr.). With the other arrangements, the time varied from twenty-four to thirty-three hours (up to 6,600 mg-hr.).

On occasion, contraction of the vaginal apex prohibited the use of the regular vaginal applicators; in these cases, five 10 mg. platinum needles (active length of 1 cm.) were inserted in the rim of the cervix and usually a tandem containing 100 mg. was introduced into the uterus (duration of application was 30 hours—4,500 mg-hr.). The platinum tandem tube with its rubber coating made an applicator which was quite bulky and because of this at times it could not be introduced into the cervical and uterine canals.

In January, 1938, a major change was made in the radium applicators. Instead of platinum, brass tandem tubes and vaginal capsules were made up of such wall thickness that with the 0.3 mm. thickness of the platinum needles, a total equivalent filtration of 0.5 mm. of platinum was achieved. Since the secondary electrons ejected from brass by the gamma radiation are of low energy, rubber coating of these applicators became unnecessary and the bulk of the tandem tube was markedly reduced (to 5.5 mm. diameter); in only rare instances has failure attended introduction of this tube

into the uterus. The usual distribution of radium in the brass applicators was 30 mg. in the cervical portion of the tandem and 20 mg. in the uterine portion; with 20 mg. in each of the vaginal applicators. The standard duration of the application was fifty-six hours (5,040 mg-hr.). The tandem tube was provided with an extension which added a third chamber (containing 20 mg.) for cases with unusually long uterine canals; the duration of fifty-six hours was maintained when this arrangement was employed. Of course, as is readily conceived anatomical situations were occasionally encountered which prevented the standard type of application, making modification necessary.

The last change in detail of technique was made in June, 1943, at which time the dense type of sponge rubber which had been used to hold the vaginal applicators in place became unavailable. The so-called modified London type of vaginal applicator was then used. This consists of a bakelite capsule of outside diameter of 1.5 cm. provided with a long removable handle. The radium-containing brass capsule was placed within the bakelite capsule and the latter inserted into the lateral vaginal fornices and held in place during the packing of the vagina; when fully packed, the handles were unscrewed and removed without altering the position of the applicators.

The data presented in this paper are given in terms of percentage of survivors at given times after treatment. Survivors are defined simply as patients alive at the stated time. The patient may be free of neoplasm or may harbor neoplasm; the patient's status in this respect may not be determinable or may be unknown. As long as the patient is alive at any given time, she is classified as a survivor at that time. Conversely, no distinction is made regarding cause of death; no adjustment is made for those patients dying of causes unrelated to the carcinoma of the cervix even though no evidence of the neoplasm is present at the time of death. There are no untraced cases. All follow-up dates to December 31, 1944.

The data on survival are presented

through the medium of the survival curve in which the years after treatment are plotted along the horizontal axis and the percentage survivors along the vertical axis. The curves themselves are not drawn; the percentage survival figures are tabulated by the years after treatment. This method is used, since with the number of curves given, it permits more facile comparison between the curves than would be

tients equals 1,225. Each row of the table gives for each of the twelve years the survival percentages for the consecutive years after treatment. Each column of the table provides immediate comparison of survival percentages at corresponding post-treatment times for the twelve groups.

Survival curves were calculated for each of the twelve years' experience rather than grouping the cases in larger masses because

TABLE II  
"ABSOLUTE" SURVIVAL CURVES

Year of Treat- ment	Num- ber	Years after Treat- ment	Survivors per cent											
			1	2	3	4	5	6	7	8	9	10	11	12
1932	86		55.8	37.2	32.6	30.2	25.6	24.4	23.3	23.3	20.9	19.8	19.8	19.8
1933	88		59.1	32.2	27.3	23.9	20.5	19.3	18.2	18.2	17.1	17.1	12.5	
1934	109		57.8	38.5	30.3	24.8	24.8	22.9	22.9	20.2	20.2	17.4		
1935	105		61.9	39.1	32.4	24.8	23.8	21.9	21.9	21.9	20.9			
1936	118		61.0	40.7	34.8	33.1	30.5	29.7	28.8	26.3				
1937	90		60.0	46.7	38.9	35.6	34.5	33.3	31.1					
1938	104		73.1	66.3	57.7	51.9	49.1	47.1						
1939	107		65.4	53.3	46.7	43.9	40.2							
1940	87		58.7	47.1	41.4	39.1								
1941	105		75.2	61.0	50.5									
1942	125		78.4	60.8										
1943	101		78.2											

the case if they were either superimposed or plotted separately.

The total survival curve (in so far as it exists for any group of patients) is used rather than any single survival figure such as the "3 year" or "5 year" percentage. Such a curve presents complete information regarding survival and permits comparison at any point along it, as well as study of the shape of the curve. Presentation of survival data in terms of a single point on the curve omits information which may prove ultimately to be of value.

In Table II are given the survival curves, in tabular form, as calculated on an "absolute" basis, for each of the years 1932 to 1943 inclusive. The relatively large number of cases renders curves for each year practicable and apparently significant; the number varies from a minimum of 86 to a maximum of 125. The total number of pa-

our chief interest has been to detect and observe the trend of the results of treatment with the passing of time in order to determine whether changes in treatment technique and increasing experience has been followed by higher survival rates. Survival curves calculated on larger patient groups may effectively obscure any such changes as may gradually or suddenly take place.

A variety of interesting observations can be made on the data contained in Table II in respect to the results of each year's work but one's curiosity at once stimulates a comparison of the results obtained in the various years. For example, it is noted that at five years after treatment the survival percentage of 25.6 for the 1932 cases drops to 20.5 for 1933, rises slightly for 1934 and 1935 but changes abruptly for 1936 to 30.5 per cent and is still higher for the subse-

quent years of 1937 to 1939. A somewhat similar pattern of change is detected in any of the other columns though the rise is smoother for the first and second years after treatment. There seems to be no doubt that in the later years, the results of therapy are considerably better than those obtained in the years 1932 to 1935 inclusive. The improvement seems to be correlated with the sharp change in irradiation technique that was made in the middle of the year 1936 when the multiple series of modified "saturation" technique of roentgen irradiation

The influence of variation, from year to year, in the distribution of patients among the various stages of the disease can be eliminated by means of a "standardized" survival curve. This is done by setting up an arbitrary group of cases, 100 in number, within which the frequency distribution in regard to anatomical extent is made to correspond to the average distribution of the entire group of the 1,225 patients that are being dealt with. The survival experience within each clinical group for each year is applied to the "standard" clinical

TABLE III  
DISTRIBUTION OF CASES IN RESPECT TO ANATOMICAL EXTENT  
(Percentage of Total for each Year)

Anatomical Extent	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943
Clinical Group I	2.3	4.5	2.8	1.9	2.5	4.4	3.8	3.7	1.2	0.0	4.0	3.0
Clinical Group II	8.1	9.1	11.9	9.5	11.0	11.1	9.6	8.4	11.5	8.6	8.0	11.9
Clinical Group III	24.4	23.9	25.7	29.5	25.4	13.3	22.1	14.0	10.3	16.2	14.4	13.9
(Total)	(34.8)	(37.5)	(40.4)	(40.9)	(38.9)	(28.8)	(35.5)	(26.1)	(23.0)	(24.8)	(26.4)	(28.8)
Clinical Group Iva	54.7	47.8	45.8	41.9	40.7	51.1	42.3	45.8	54.0	49.5	40.8	38.6
Clinical Group Ivb	5.8	12.5	12.8	13.3	15.3	15.6	21.2	25.2	21.8	20.0	28.0	26.8
Clinical Group Ivc	2.3	2.3	0.9	1.9	2.5	3.3	0.0	2.8	1.2	2.9	4.0	5.0
Unclassified	2.3	0.0	0.0	1.9	2.5	1.1	1.0	0.0	0.0	2.9	0.8	1.0
(Total)	(65.1)	(62.6)	(59.5)	(59.0)	(61.0)	(71.1)	(64.5)	(73.8)	(73.0)	(75.3)	(73.6)	(71.4)

was abandoned and replaced by the single course of fractional irradiation as described previously.

An obvious and serious objection exists to such a direct comparison of these survival curves: namely, are there not, in the twelve groups of patients, differences in the distribution of the cases in respect to the anatomical extent of the lesions? May not the improvement be only apparent and actually be due to the presence in the later years of a greater proportion of cases with lesser extent of the neoplasm? Examination of the data reveals that the distribution of the cases among the clinical groups (that is, the stages of the disease) does vary in the twelve years experience that is being presented (see Table III) but the variation is such that the later years have a somewhat lower, rather than a higher, proportion of patients with lesions of limited anatomical extent. Therefore the better results from 1936 on cannot be explained on this basis.

groups; for each year the results of this procedure are combined to give the "standardized" survival curve. Since now the distribution is identical for each of the twelve years, comparisons can be made directly.

The "standardized" survival curves ("absolute") are presented in Table IV. The standard distribution used for these curves was as follows: Clinical Group I—3 cases, Clinical Group II—10 cases, Clinical Group III—20 cases, Clinical Group Iva—46 cases, Clinical Group Ivb—18 cases, Clinical Group Ivc—2 cases, Unclassified—1 case (total equals 100).

When the five year results in Table IV are studied in relation to those in Table II, it is seen that the figures have changed so that most are somewhat lower but not markedly so. For the year 1939, the standardized figure is greater than the crude one of Table II (43.3 instead of 40.2). Despite these changes there still remains a transition point, the year 1936, from poorer re-



TABLE IV  
 "STANDARDIZED" "ABSOLUTE" SURVIVAL CURVES

Year of Treatment	Number	Years after Treatment	Survivors per cent											
			1	2	3	4	5	6	7	8	9	10	11	12
1932	100		52.4	33.3	29.4	27.5	23.2	22.2	21.2	21.2	19.3	18.4	18.4	18.4
1933	100		56.2	33.4	26.1	22.6	19.2	18.2	17.0	17.0	15.3	15.3	11.1	
1934	100		52.7	34.0	26.9	22.2	22.2	20.5	20.5	18.0	18.0	15.6		
1935	100		59.3	35.9	30.2	21.9	20.8	19.2	19.2	19.2	18.5			
1936	100		58.8	38.7	33.2	31.5	28.9	27.9	27.2	24.6				
1937	100		58.6	46.2	37.6	33.9	32.9	31.9	29.9					
1938	100		72.1	65.5	56.9	51.4	48.8	47.0						
1939	100		69.9	58.1	50.3	47.0	43.3							
1940	100		62.4	49.9	43.7	41.7								
1941	100		77.8	63.9	53.5									
1942	100		83.4	66.2										
1943	100		83.4											

sults prior to and higher survival figures after that year. The other columns show a similar pattern.

In Figure 1 this pattern is depicted graphically. The vertical axis gives the percentage survivors; the survival figures at the available post-treatment years (1, 2,

3, etc.) for *each* of the twelve groups (years 1932 to 1943 inclusive) are plotted on an individual ordinate which is identified along the horizontal axis. All the points indicating the survival percentage at 1 year after treatment are connected; the same is done for the 2 year, the 3 year, etc., points.

As each curve is followed from left to right (that is, from the year 1932 towards the ordinate for 1943), it is seen that all the curves which reach or pass 1936 rise to higher survival percentages. The portions of the curves between 1932 and 1935, in general, tend to be horizontal and at a level which is considerably lower than from 1937 on. From 1937 on, in general, the curves show a tendency to rise rather than to remain flat. The year 1936 is a transitional one with its levels situated between the low figures of 1932-1935 and the higher figures of 1937 onwards. This is an interesting point because, as has already been noted, the roentgen irradiation technique was changed in this year. The impression is gained from examining the curves from 1937 to 1943 that improvement in results is still occurring.

An analysis, similar to that embodied in Figure 1, was carried out for each stage of the disease to determine in which stage or stages the improvement in results took

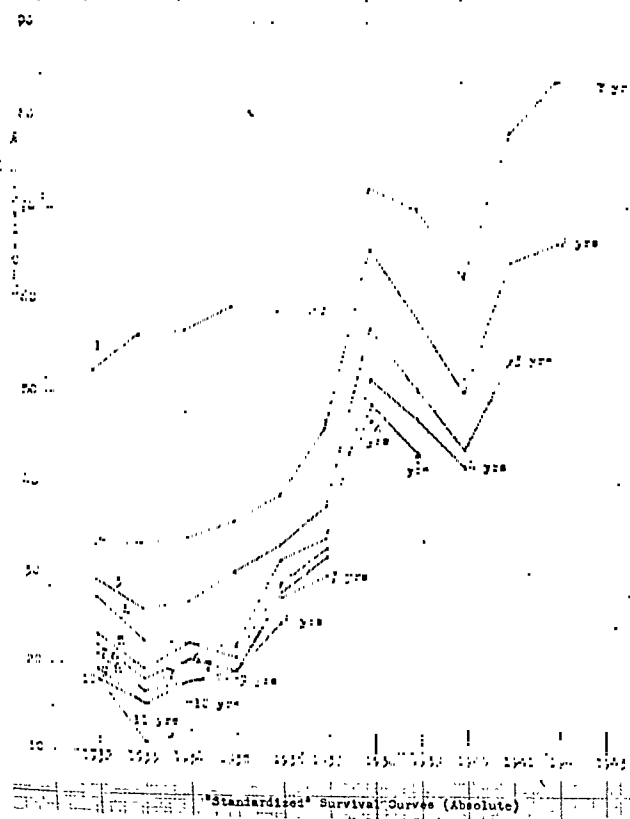


FIG. 1

place. This demonstrated that the increase in survival percentages for cases treated during the later years is greatest in clinical Group Iva, somewhat less marked in clinical Group III and although slight for clinical Groups I, II, and IVb, the tendency towards better results is present.

The suggestion has been made that it is not necessary to wait for the lapse of five years after treatment in order to be able to evaluate results, that the figures available at three years should be adequate indicators. Stated in other words, this means that the survival curves should have similar shapes and therefore the results at five years are predictable on the basis of the experience of survival at three years after treatment. This is an interesting point to investigate with the multiple curves presented in Table IV (the "standardized" rather than the crude curves are used). In Table V are shown the ratios of the 5 year to three year survival percentages for each year-group for which they are available, and also the 5 year to 2 year ratios.

The higher ratios for the years 1936 to 1939 are a partial expression of the fact which we have already observed, namely that the results were better in those years than in the earlier years of 1932 to 1935. Interesting is the fair agreement of the ratios within the 1932 to 1935 group, with the 5 to 3 year ratio varying essentially from 0.7 to 0.8 and the 5 to 2 ratio from 0.6 to 0.7. For the 1936 to 1939 groups both the 5 to 3 and the 5 to 2 ratios show such

TABLE V

Year of Treat- ment	RATIO:	RATIO:
	5 yr. survival % 3 yr. survival %	5 yr. survival % 2 yr. survival %
1932	0.79	0.70
1933	0.74 Average	0.59 Average
1934	0.79 equals 0.75	0.65 equals 0.66
1935	0.69	0.69
1936	0.87	0.75
1937	0.88 Average	0.71 Average
1938	0.86 equals 0.87	0.75 equals 0.74
1939	0.86	0.75

TABLE VI

Year of Treat- ment	5 year survival (per cent) ("standardized")
1932	23.2
1933	19.2
1934	22.2
1935	20.8
1936	28.9
1937	32.9
1938	48.8
1939	43.3
1940	38.0 Prediction on basis of 5:3 yr. ratio 36.9 Prediction on basis of 5:2 yr. ratio
1941	47.6 Prediction on basis of 5:3 yr. ratio 47.3 Prediction on basis of 5:2 yr. ratio
1942	48.8 Prediction on basis of 5:2 yr. ratio

good agreement that they may be considered essentially constant. It is apparent that in these data the shape of the survival curve changes with improvement in results of treatment; that is, the results are not better solely because of a higher percentage being alive at 3 years (or 2 years) but also because the rate of decline of the curve between 3 years (or 2 years) and 5 years becomes less. This being the case, prediction of the 5 year figures from 3 year results must be undertaken with considerable caution. Indeed such attempts at prediction may prove quite misleading *unless* there exists evidence pointing to a high probability that the shapes of the curves are constant. Such appears to be the case in our data in as much as, on one hand, the ratios for the years 1936 to 1939 are essentially equal and, on the other hand, no marked changes in therapeutic technique have taken place since 1939. In Table VI, where the survival percentages at 5 years are taken from Table IV for the years 1932 to 1939, the probable 5 year results for 1940, 1941, and 1942, based on both the 5 to 3 year ratio (0.87) and the 5 to 2 year ratio (0.74) are shown.

It is generally agreed that the most important factor determining the probability of eradication of carcinoma of the cervix is the anatomical extent of the neoplasm. With tumors of limited extent, the chance

of successful eradication is high whereas with far-advanced lesions the ability to cure becomes practically nil. In a very real sense, one may view the early and the late stages as different diseases so far as the result of interaction of the disease and its treatment is concerned. The progressive

the degree of histopathological differentiation, the same phenomenon appears to persist. In Table ix are presented survival curves for histopathological Grade 2 and Grade 3, each subdivided into clinical Groups II, III, and IVa. The other possible combinations of histopathological grade

TABLE VII

"ABSOLUTE" SURVIVAL CURVES FOR THE COMBINED YEARS 1932-1939 INCLUSIVE

Clinical Group	Number	Years after Treatment	Survivors per cent				
			1	2	3	4	5
I	26		88.5	84.5	80.7	80.7	80.7
II	80		90.0	71.3	66.2	58.8	55.0
III	181		81.2	63.5	53.0	48.6	46.4
IVa	370		60.8	41.1	33.2	28.7	25.9
IVb	125		24.0	12.0	9.6	8.0	6.4
IVc	16		6.2	6.2	0.0	0.0	0.0
Unclassified	9		22.2	0.0	0.0	0.0	0.0

TABLE VIII

"ABSOLUTE" SURVIVAL CURVES FOR THE COMBINED YEARS 1936-1939 INCLUSIVE

Clinical Group	Number	Years after Treatment	Survivors per cent				
			1	2	3	4	5
I	15		93.4	86.7	86.7	86.7	86.7
II	42		90.5	71.5	66.7	64.3	61.9
III	80		87.5	78.8	65.0	58.8	56.3
IVa	187		67.4	51.3	43.8	40.7	37.4
IVb	81		27.2	16.0	13.6	11.1	8.7
IVc	9		11.1	11.1	0.0	0.0	0.0
Unclassified	5		20.0	0.0	0.0	0.0	0.0

seriousness of the prognosis with increased anatomical extent of the neoplasm is well shown in Table VII in which the survival curves for each clinical group have been prepared from all the patients for whom at least five years have elapsed since treatment (that is, the years 1932 to 1939 inclusive); and also in Table VIII in which the results for the combined years 1936 to 1939 inclusive are shown. The contrast between the curves in these tables again demonstrates the better results of the later years.

It is of interest that when a somewhat more rigorous control is exercised over these data by eliminating the variation in

and clinical group are not shown because the number of cases for each curve becomes too small; indeed the 19 cases for the histopathological Grade 2:clinical Group II curve is an inadequate number.

The comparisons made on the differences in results obtained in the twelve groups (each representing the patients treated in one year) were carried out after converting the crude curves of Table II into the "standardized" curves of Table IV by standardizing the frequency distribution of anatomical extent. Such comparisons may be criticized on the grounds that although the effect of variation of anatomical extent

has been eliminated, the possible influence of variation in degree of histopathological differentiation has not been considered. Simply to set up for each year survival curves based on the degree of histopathological differentiation, disregarding anatomical extent, and then to standardize these, does not suffice. Certainly such a procedure will succeed in eliminating the influence of variation in histopathology but concealed in the curves will be the factor of

frequency of occurrence (in per cent) of each combination for each of the twelve years. All of the points for each year are connected by straight lines. Thus an irregular curve showing variation in per cent occurrence of each combination of clinical group and histopathological grade is present for each year and the twelve curves for the twelve years are superimposed. The dispersion of the points on each ordinate gives a visual image of the variation in

TABLE IX  
"ABSOLUTE" SURVIVAL CURVES FOR THE COMBINED YEARS 1932-1939 INCLUSIVE

	Clinical Group	Number	Years after Treatment	Survivors per cent				
				1	2	3	4	5
Histopathological Grade 2	II	19		84.2	57.9	52.6	42.1	42.1
	III	50		82.0	60.0	40.0	38.0	36.0
	IVa	87		56.3	37.9	31.0	25.3	21.8
Histopathological Grade 3	II	47		91.7	72.9	68.7	60.4	60.4
	III	97		79.4	61.9	53.6	48.5	46.4
	IVa	226		65.0	43.4	35.8	31.0	28.3

extent—which factor is regarded today as of major importance as a parameter of treatment results. It would be necessary to set up for each year (1932 to 1943) individual survival curves for each of the thirty-five possible combinations of histopathological grade and clinical group before proceeding with elimination of variation in frequency of these thirty-five combinations among the twelve groups, by the process of standardization. By the time the cases of each year are divided among the thirty-five combinations, the number of cases per curve obviously becomes too small to deal with.

In seeking to determine whether sufficient variation in degree of histological differentiation exists between the twelve groups compared in Table II to make such a comparison invalid, two aspects of the data were studied. First, a graphic depiction was made (Fig. 2) in which along the horizontal axis are laid out the thirty-five combinations of clinical group and histopathological grade. On the ordinates are plotted the

frequency of each combination among the twelve years. In general it may be said that the variation is not excessive.

The second approach was by listing the numerical values of the combinations in tabular form and carrying out an analysis of variance to determine whether these distributions presented significant differences. This type of analysis was unable to prove that a significant difference existed in the distribution of the cases among the thirty-five combinations between the twelve groups under consideration. Thus, although not unequivocally established, it seems unlikely that sufficient variation in degree of histopathological differentiation exists to invalidate comparison of the survival curves shown in Table IV.

The question whether the degree of histopathological differentiation of carcinomas of the cervix is of importance in its effect on results of treatment is of interest and of obvious significance. As discussed above, the difficulty in answering this question is based on the fact that, before comparisons

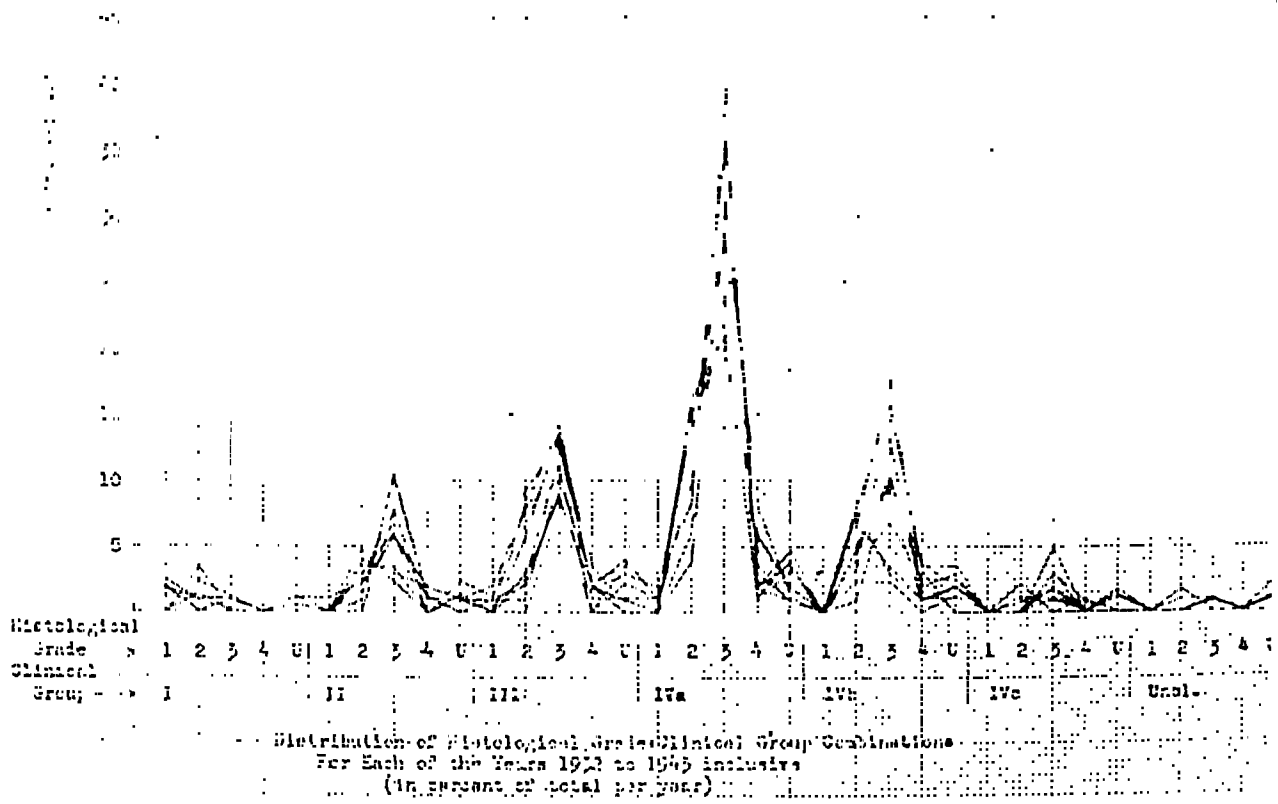


FIG. 2

of degree of differentiation can be made, first the effect of anatomical extent must be excluded. By the time this is done, the numbers of cases which must be dealt with become so small that it is difficult to demonstrate that any differences which may exist are significant ones.

From the cases treated in the years 1932 to 1939 inclusive (that is, for which five years or more have elapsed since the time of treatment), some data may be pre-

sented on this matter and appear in Table x. For each of the clinical Groups II, III, and IVa, survival curves have been calculated using cases of like histopathological differentiation for each curve. Only groups which consisted of 15 or more cases are shown. Curves for histopathological Grade 2 and 3 are available from the clinical Group II cases, while from the clinical Group III and IVa cases, curves for histopathological Grades 2, 3 and 4 are available.

TABLE X  
"ABSOLUTE" SURVIVAL CURVES FOR THE COMBINED YEARS 1932 TO 1939 INCLUSIVE

Histopatho- logical Grade	Number	Years after Treatment	Survivors per cent				
			1	2	3	4	5
Clinical Group II	2	19	84.2	57.9	52.6	42.1	42.1
	3	48	91.7	72.9	68.7	60.4	60.4
Clinical Group III	2	50	82.0	60.0	40.0	38.0	36.0
	3	97	79.4	61.9	53.6	48.5	46.4
	4	15	86.7	73.3	73.3	60.0	60.0
Clinical Group IVa	2	87	56.3	37.9	31.0	25.3	21.9
	3	226	65.0	43.4	35.8	31.0	28.3
	4	32	40.6	18.8	15.6	15.6	15.6

Examination of these curves reveals that for each of the 3 clinical groups the survival percentage is higher for histopathological Grade 3 cases than for histopathological Grade 2 cases. This suggests that with increased de-differentiation of the neoplasm, the results of radiation therapy become better. The fact that in the clinical Group III cases the survival figures for the histopathological Grade 4 cases are even higher than the histopathological Grade 3 figures seems to add weight to this suggestion.

Before one accepts this suggestion as fact, several things should be noted. First the apparent rule of increasing survival percentages with increasing anaplasia is violated by the curve for the Clinical Group Iva—histopathological Grade 4 cases which at all points is lower than either the histopathological Grade 3 or Grade 2 cases. Of course, one could postulate that such an advanced anatomical extent as clinical Group Iva effectively wipes out the favorable reaction to irradiation of a highly de-differentiated neoplasm and with the exception thus explained, assume the validity of the rule in cases of lesser anatomical extent than clinical Group Iva. However, if one scrutinizes the data closely there seems to be reason for not accepting this statement. In particular it should be noted that there are three curves based on relatively small numbers: clinical Group II—histopathological Grade 2 on 19 patients, clinical Group III—histopathological Grade 4 on 15 patients, and clinical Group Iva—histopathological Grade 4 on 32 patients. With such small numbers the error involved in sampling variation may well be high. If the validity of these curves is doubtful, then it is futile to postulate any explanation, however plausible, for the exception, embodied in the clinical Group Iva—histopathological Grade 4 curve, to the apparent rule and one is forced to eliminate from consideration one curve from each of the three clinical groups presented in Table x. Therefore clinical Group II drops out of the picture entirely, since only one curve is left. Clinical Groups III and Iva still have

two curves each, namely, for histopathological Grades 2 and 3, and these still show that for comparable anatomical extent the histopathological Grade 3 cases show higher survival rates than the histopathological Grade 2 cases.

This matter of a possible correlation between survival results and degree of differentiation of the neoplasm is one of very considerable theoretical and practical importance. Before accepting such a correlation as established, one must inquire whether it is possible that some other factor may account for the differences exhibited by these survival curves. Such a factor does exist.

Our survival curves for the histopathological Grade 2 and 3 cases in clinical Groups III and Iva are samples from a theoretically infinite population of such cases. In effect what we have done is to dip into this infinite population and remove relatively small samples of it. If one withdraws many such samples, he will observe that there may be considerable differences between them, differences which are due solely to the random selection of a sample from a population, the members of which show some variation. The variation between the samples is known as sampling variation. Before differences between two samples can be accepted as significant, it must be shown that the likelihood of this difference being due to sampling variation must be slight.

In our data it must be demonstrated that the difference in survival percentages for the histopathological Grade 2 and 3 cases in clinical Group III (and likewise in clinical Group Iva) is unlikely to be due to sampling variation before we can accept these differences as being real. Comparable points along the survival curves such as the three year and five year points were studied by means of the chi square test and in none was a significant difference found. In other words, such differences as do exist at comparable points along these survival curves have a high likelihood of being due to sampling variation.

The chi square test, dealing as it does with only one point on each of the two curves that are being compared, does not take into account the total survival experience contained in each curve. To use the entire formation available in each of the two curves it is desirable to compare the curves in their entirety. It is possible to do this by applying the method developed by C. I. Bliss for the calculation of the "time-mortality" curve.\* Using this approach a mean and standard deviation can be found (in transformed time units) for each curve and tests of significance of a difference between two means can be carried out in the usual fashion. This was done for the survival curves for the histopathological Grade 2 and Grade 3 cases in clinical Group III and no significant difference between the means of the curves was found. The same result was obtained for the curves for histopathological Grade 2 and Grade 3 in clinical Group IVa.

The results of these analyses lead us to the following conclusion. The higher survival percentages of the histopathological Grade 3 cases as compared to the Grade 2 cases suggests that increasing anaplasia of the neoplasm is an important factor in obtaining better results with radiation therapy. However, with the number of cases present in our data, *it cannot be proved* that the difference between the survival figures for Grade 3 and Grade 2 cases is a significant one—there is a high likelihood that this difference is due solely to sampling variation. On the other hand, the possibility that increasing anaplasia gives rise to better results in radiation treatment *is not excluded* by our data. With more cases, the difference, if it persists, may turn out to be significant. The fact that two independent sets of data (the curves for the clinical Group III cases and the curves for the clinical Group IVa cases) show the same type of difference makes this seem likely.

\* See "The Calculation of the Time-Mortality Curve." *Annals of Applied Biology*, 1937, 24, 815-852, with special reference to section III dealing with incomplete time-mortality curves for truncated distributions.

At the moment the entire matter must rest at this point until more cases become available for analysis.

#### SUMMARY

1. The survival experience in carcinoma of the cervix uteri following radiation treatment at the University of Michigan, calculated on an "absolute" basis, is presented for each of the twelve years 1932 to 1943 inclusive by means of survival curves (total number of patients, 1,225).

2. Comparison of results for each of the twelve years, following elimination of the effect of variation in frequency distribution of anatomical extent by means of the so-called "standardized" survival curve, demonstrates the "absolute" five year survival percentage to have risen from between 20 to 25 per cent for the years 1932 to 1935 inclusive to above 40 per cent for the years 1938 and 1939. Study of the four, three and two year survival curves indicates that this gain is essentially maintained for the years 1940 to 1942 inclusive.

3. Analysis of the survival curves for the twelve years shows that prediction of five year results on the basis of three year survival figures may be misleading unless there is some evidence to indicate that the shape of the survival curve has not altered.

4. The decreasing survival percentages with increasing anatomical extent of the neoplasm is well demonstrated by the survival curves calculated for each clinical group (stage of the disease).

5. Evidence is presented which suggests that the distribution of the cases among the grades of histopathological differentiation is not significantly different among the twelve years.

6. Some evidence is found in the data which suggests that the results are better in the less well differentiated neoplasms. This suggestion cannot be accepted as proved since analysis shows that the difference in results may be due solely to sampling variation.

University Hospital  
Ann Arbor, Mich.

# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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# EDITORIALS

## VARIOUS CONDITIONS INFLUENCING ROENTGENOGRAPHIC INTERPRETATION OF JOINT DISEASES

**A** CORRECT roentgenographic diagnosis of any joint disease depends on an awareness of the significance of certain fundamental changes which are visible in the roentgenogram; correct interpretation is otherwise impossible. Articulations are complex structures and their gross reaction to injury or disease is, in a measure, similar but certain diseases present specific patterns which are recognizable in the roentgenogram by careful attention to detail—gross and otherwise.

In a consideration of the number of diseases which affect joints it is manifest that accurate interpretation is impossible unless the roentgenologist utilizes an analytic scheme. Obviously it would be fallacious to attempt an interpretation of a lesion merely because it appears similar to one already observed.

The analysis of a roentgenogram must, as previously stressed, be developed in a schematic fashion, with a search of all the components of the articulation, for a possible clue.

The rationale in examining roentgenograms is perhaps best exemplified in the study of width or height of a diseased joint and its appearance after fusion or ankylosis.

Certain experiments carried out by Phemister and others will serve to throw light on what occurs in joint spaces under various pathologic conditions. Joint cartilage was examined and placed in two test tubes; one tube contained a culture of pyogenic organisms and the other one of tubercle bacillus. After incubation it was found that the cartilage was completely digested in the tube containing the pyo-

genic organisms while it remained nearly intact in the other culture. The explanation is a simple one. Pyogenic organisms produce a proteolytic ferment while the tubercle bacillus does not. Cartilage is consequently quickly destroyed in pyogenic infections and relatively late in tuberculosis. The practical application of this experiment is of great aid in diagnosis and differential diagnosis. It is evident, then, that infection of a joint by pyogenic organisms may lead to rapid destruction of the cartilage with consequent early narrowing of joint space. On the other hand, this narrowing in tuberculosis occurs extremely late in the course of the disease. However, destruction of cartilage, when present, is caused rather by pressure of granulations than by infection proper. In other words, appreciable narrowing of joint space which occurs in a few weeks or a few months after onset of symptoms almost invariably is caused by pyogenic infection, while negligible narrowing which occurs six months to one year after onset of symptoms is more likely to be consequent on tuberculosis or nonspecific disease.

Interpretation of a roentgenogram therefore consists in an appraisal of the duration of infection and its effect on the joint cartilage, or conversely whether the damage to the joint cartilage occurred early or late. How can we determine from a roentgenogram that the lesion is of long duration? Obviously, osteoporosis must be present or some retardation in development of the regional bones. Then again, how can one assume that the lesion is of short duration? It would seem obvious that where

cartilage is rapidly destroyed the degree of atrophy in no way will be commensurate with the extent of the narrowing of the joint space; in other words, cartilage is destroyed so quickly that there is insufficient time for the development of pronounced osteoporosis. It is manifest therefore that the age of a lesion can be determined within certain limits from the roentgenogram and by indirection, the diagnosis is based on obvious clues.

An evident corollary is the consideration of the character, degree and variety of ankylosis which results in joint infections. Rapid destruction of cartilage in pyogenic infections of joints is associated with early exposure of subchondral bone. There is a fairly uniform exposure in this area in virulent infections. The process of destruction is complete. When this bone is exposed the tendency to union of exposed surfaces is always present. Where moderate or excessive destruction follows severe infection ankylosis is likely to result fairly rapidly and evenly throughout the joint. Where destruction or superficial necrosis of the joint cartilage follows an infection a limited local repair may result but there is always a tendency to fibrous ankylosis. This change is not demonstrated roentgenographically and the roentgenogram may therefore be uninformative.

On the other hand, where cartilage is irregularly destroyed by granulation tissue, such as occurs in tuberculosis, the necrosis is irregular and at an unequal pace and unevenly distributed. Residual areas of articular cartilage consequently will remain. If fusion occurs it will be late and extremely irregular, with the joint space visible in certain areas and completely obliterated elsewhere. It is obvious therefore that under the aforesaid conditions it is possible to determine the probable etiological factor.

This logically leads to a consideration of the changes which occur at the margins of the joint in pyogenic and tuberculous infections. The tendency for marginal bone proliferation is great in the nonspecific

arthritides and apparently not to the same degree in pyogenic infections and negligible in tuberculosis. Utilizing hypertrophic changes as a criterion on which to base a diagnosis certain facts must be kept in mind, to wit:

(1) Excessive bone produced at articular margins takes years to develop. It may be asked: "Of what importance is a study of the width of joint space when these changes are present?" It is clear that severe infection produces great narrowing of a joint space or complete obliteration. It would seem evident, therefore, that the presence of hypertrophic marginal changes concurrent with a relatively intact joint space indicates a non-suppurative or so-called metabolic arthritis. If there is notable narrowing of the joint it is an indication of a great age of the lesion.

(2) The absence of pronounced marginal hypertrophic changes, with an irregularly destroyed but still visible joint space in a lesion which is of some years' duration, indicates a process wherein osteogenesis is poor. It is evident that tuberculosis is in this category.

(3) In a lesion where obliteration of joint space is complete, where fusion is orderly and where marginal hypertrophic changes are not unusually prominent, there is a strong assumption that one is confronted with an old infection which has "burnt out" after destruction of articular cartilage. This is frequently observed in old gonorrheal arthritis.

(4) When excessive marginal bone is produced concurrently with necrosis of sub-cortical bone and irregular calcification of soft parts, it would seem that we are dealing with an extremely virulent infection. The mere fact that there is a tendency to production of excessive bone would itself nullify the diagnosis of tuberculosis. It must be borne in mind that the presence of a sinus in tuberculosis suggests a mixed infection and that it overshadows the picture. It is erroneous, therefore, to speak of a characteristic appearance of tuberculosis in such a situation. Roentgenographically, the

lesion is that of a low grade infectious and destructive arthritis which adumbrates the specific pattern of tuberculosis.

In summary, then, it may be said that the correct identification of the disease causing production of significant variations in width of a joint space requires, a priori, a study of the probable time-element in the process of active destruction, keeping in mind, as already stated, that rapid narrowing of joint space may occur in suppurative infections and late in tuberculosis. The diagnostic problem is difficult

when an adequate joint space is present. The indication then must be that we are dealing with a metabolic arthritis—a suppurative arthritis which has subsided, or else with a moderately advanced tuberculous arthritis.

By noting merely two common changes associated with joint disease, an endeavor has been made to point out the best diagnostic method rather than a formula.

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CLARENCE EDWARD SKINNER  
1868–1947

**D**R. CLARENCE EDWARD SKINNER, a charter member of the American Roentgen Ray Society, died on April 24, 1947, at his home in Darien, Connecticut. He was born in New Haven in 1868. At his graduation from Yale University School of Medicine in 1891 he shared with Dr. Reuben A. Lockhart the Keese

Prize for the best thesis. His topic was "The Microscopic Differentiation of the Hair of Man from that of the Lower Animals." This is believed to be the first extended investigation of this subject.

Dr. Skinner practiced medicine in New Haven from his graduation until 1914. In 1900 he established the Newhope Private

Sanitarium, the first institution in that region to be equipped for physiotherapy. This sanitarium merged in 1908 with the Elm City Private Hospital. His book "Dry Hot Air as a Therapeutic Agent" went through three editions between 1902 and 1914. At the International Congress of Physiotherapy held at Liege in 1904 it was awarded the Diplome d'Honneur by the Belgian Government. He received the honorary degree of LL.D. from Rutherford College in 1901 in recognition of his pioneer work in physiotherapy. It was some time before physical medicine achieved any prestige in the eyes of the medical profession at large, and Dr. Skinner's early efforts helped to bring this recognition about.

In 1914 Dr. Skinner removed to New York and was thereafter engaged in special medical work for life insurance and health conservation organizations. From 1919 to 1927 he was medical director of the Postal Life Insurance Company and was medical examiner in chief and consultant at the home office of the New York Life Insurance Company from 1924 until he retired in 1939.

Dr. Skinner was a Fellow of the American Medical Association and of the New York Academy of Medicine; a member of the

Connecticut State and New Haven County Medical Societies; in 1905-1906, he was vice-president of the American Roentgen Ray Society; in 1902-1905, he was secretary of the American Electro-Therapeutic Association. He was a Foreign Member of the Société Française d'Electrothérapie et de Radiologie. He was the secretary of the class of 1891 of the Yale Medical School. After serving from 1936 to 1942 as chairman of the Darien Chapter of the American Red Cross he was elected honorary chapter chairman for life. He was an Episcopalian and a Royal Arch Mason. He was a member of the Quinnipiac, Union League, New Haven Yacht and New Haven Economic Clubs and the New Haven Historical Society of New Haven, and of the National Arts and Salmagundi Clubs of New York. In 1933 he established his home in Darien and lived there until his death, which occurred at the age of seventy-eight years, from coronary occlusion.

Dr. Skinner was married in 1896 to Edith Hart Hotchkiss of New Haven, who died in April, 1922. He was married to Anne Mae Gardner of New York, who survives him, in June, 1923.

RAMSAY SPILLMAN





EDWARD EVERETT ROWELL  
1878-1947

DR. EDWARD E. ROWELL died on July 13, 1947, at his home in Stamford, Connecticut. The cause of his death was lymphosarcoma. He was incapacitated for only a few months, although he had begun to lose weight almost three years before. Other symptoms apparently referable to it dated back as far as fourteen years.

A resident of Stamford since 1880, a practicing physician there since 1900, he served on the Common Council of that city from October, 1934, until his enforced retirement a few months before his death. For nine years he was president of the council. His father, Dr. Charles E. Rowell, was Mayor of Stamford from 1910 to 1913.

At the time of Dr. Rowell's death, the present Mayor, the Hon. Charles E. Moore, issued the following statement:

"Dr. Rowell's place in our community will not soon be filled. Few in the history of our city have rendered the unselfish service that has characterized his every act in public life. He was true to the traditions of his distinguished family, members of whom had contributed so much toward the advancement, progress and civic life of our community. Through the years many of our citizens have served Stamford and left behind enviable records. Dr. Rowell's name will appear high on that distinguished roll. He was a true and loyal friend at all times but never was blinded by friendship when the public welfare was at stake. Possessed of a strong mind with unbending loyalty to his trust, he was ever alert and ready to champion the cause of right as he saw it. No power influenced him other than the desire to honorably discharge his public trust. Even though we disagreed with him on occasion and he violently disagreed with us, all must come to the inescapable conclusion that he was controlled by his own conscience as he saw the right. We extend our heartfelt sympathy to the bereaved wife, brother and relatives. Stamford has suffered an irreparable loss. Out of respect to the memory of this loyal, honorable and unselfish public servant, I respectfully request that all flags throughout the city be flown at half mast."

This is a tribute which any one who was privileged to know Dr. Rowell as a colleague will endorse. He was a dynamic person of unquestionable integrity. Born in Lancaster, New Hampshire, September 13, 1878, he was two years old when his family moved to Stamford. He had a summer home at Littleton, New Hampshire. He graduated in medicine at Hahnemann in Philadelphia in 1899. He served the Norwalk Hospital for twenty-seven years, the Greenwich Hospital for twenty-five, and St. Joseph's Hospital in Stamford for five years. He was health officer of Stamford from 1913 until he entered the army in 1917. In World War I he was a roentgenologist in the United States and overseas.

He was married in 1921 to Miss Madelyn Geronimo, who survives him. There is a brother, Dr. James Frederick Rowell, in Lawton, Oklahoma, and another brother, no longer living, George P. Rowell, was a prominent lawyer. Dr. Rowell's membership in the American Roentgen Ray Society dates from 1923. In 1929-1930 he was president of the New York Roentgen Society. He was also a fellow of the American College of Radiology and a member of the Radiological Society of North America. He was for ten years president of the Hubbard Heights Golf Club, and was also a gardener and a horseman. One of his friends observed that he got much out of life because he put much into it.

RAMSAY SPILLMAN





JOHN LEONARD KANTOR  
1890–1947

DR. JOHN LEONARD KANTOR, sometime intern in Mount Sinai Hospital, New York, married Miss Ina Downes, a Canadian girl of Scotch origin, a nurse in the same hospital, on October 20, 1919. She was a head nurse overseas with the Mount Sinai Hospital in the first World War. They have two sons, Dr. Thomas

Gordon Kantor, now in the United States Army Medical Corps, and James Downes Kantor, a veteran of overseas service. Mrs. Kantor was not in the best of health when Dr. Kantor, then Colonel Kantor in World War II, was in the Army in New Guinea. The older boy was in medical school, the younger was overseas, and their



mother was living alone. The war had finished, and life was returning to normal, when Mrs. Kantor on May 21, 1947, died suddenly of coronary occlusion.

One friend who esteemed Dr. Kantor highly wrote him a letter of the usual well meant and futile expressions of condolence and then laid it aside in the expectation of expressing his sympathy in person in the near future. This message was never delivered. On June 26, convalescing apparently uneventfully from an operation in Mount Sinai Hospital, Dr. Kantor was walking in the corridor talking with a colleague, when he suffered a heart attack and died.

Should some historian of medicine check the rosters of all graduating classes against recognition of their members in later years, it might be that a group could be found with a higher percentage of achievement than that of Columbia University, College of Physicians and Surgeons, 1912. It would indeed be a distinction to surpass it. John Kantor was an outstanding member of an outstanding group. If he wished, he could have worn the keys of Phi Beta Kappa, Signa Xi, Alpha Omega Alpha, and the American College of Physicians. His first medical publication was in 1911, a year before his graduation. In *Mycologia*, with Ernest D. Clark, he published "Toxicological Experiments with Some of the Higher Fungi." Up to 1943 his bibliography listed 86 journal titles, three chapters in systems of medicine, two books, and a Handbook of Digestive Diseases, the last-named in process of preparation. Dr. Anthony Kasich is completing it for publication by Mosby in 1948.

John Leonard Kantor was the son of Dr. William L. and Katharine Gordon Kantor. He took the degrees of A.B. in 1909, and Ph.D. and M.D. in 1912, all from Columbia University. In 1938 he was awarded the Conspicuous Columbia Alumni Service Medal, with the following citation: "A Columbia Alumni Fund representative who has seen the need for greater endowment for medical education and with skill and

diligence has been attracting important gifts, first for student loan funds and later for a perpetual scholarship." The class of 1912 has the additional distinction of having established a scholarship of the value of fourteen thousand dollars, raised by Dr. Kantor's drawing power among his classmates.

In his short life of fifty-seven years, John Kantor had four careers in one: clinician, teacher, military man, and husband and father. Following his internship, 1912-1914 at Mount Sinai Hospital, he spent 1915-1916 as assistant to the professor of Medicine at Syracuse University. From 1916 until his untimely death, he practiced in New York, taking time out to serve in two world wars. In the first, with the rank of Lieutenant, he was assistant chief of the medical service of U. S. General Hospital 14 at Fort Oglethorpe, Georgia. Always active in the medical reserve, taking part in field and correspondence courses and in maneuvers, he rose to the rank of colonel. In 1942 he went on active duty, and as commanding officer of the 49th General Hospital he left this country for New Guinea on February 2, 1944, returning to San Francisco March 11, 1945. He organized the first undergraduate course in gastroenterology at Columbia University in 1923, and the first post-graduate course there in 1924. At the time of his death he was associate clinical professor of clinical medicine at Columbia University, College of Physicians and Surgeons. Also at the time of his death, he was gastroenterologist and associate roentgenologist of Montefiore Hospital, New York City, gastroenterologist for Both David Hospital New York City, and a consultant for the Will Rogers Hospital at Saranac Lake, the National Jewish Hospital in Denver, and Sharon Hospital at Sharon, Connecticut.

Dr. Kantor was a member of the American Roentgen Ray Society, American College of Physicians, American Gastroenterology Association, Academy of Medicine, New York Gastroenterological Association, Association of Military Surgeons, American

Medical Association, and the State and County medical societies.

John Kantor's success in medicine and as a citizen was based not only on knowledge and intellect. He was a warm-hearted

human being and his friends and his patients were highly conscious of that great radiation of human kindness which stamped him as a great physician.

RAMSAY SPILLMAN

## PHILIPP LENARD 1862--1947

PROFESSOR DOCTOR PHILIPP LENARD, the Nobel Prize recipient in Physics, who was born in 1862 in Pressburg, Slovakia, died on June 9, 1947, in Messelhausen, Kreis Tauberbischofsheim.

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# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14-17, 1948.

#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Chicago, Ill., 1948.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21-25, 1948.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year. January, May, November.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### LOUISVILLE RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

**NEBRASKA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. O. A. Neely, 924 Sharp Bldg., Lincoln, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

**NEW ENGLAND ROENTGEN RAY SOCIETY**

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

**NEW HAMPSHIRE ROENTGEN RAY SOCIETY**

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

**NEW YORK ROENTGEN SOCIETY**

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

**NORTH CAROLINA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

**OHIO STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland. Meets during meeting of Ohio State Medical Association in Cincinnati, May, 1948.

**OKLAHOMA STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

**OREGON RADIOLOGICAL SOCIETY**

*Secretary*, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

**ORLEANS PARISH RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

**PACIFIC NORTHWEST RADIOLOGICAL SOCIETY**

*Secretary*, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting, May 21-22, 1948, Erie, Pa., at Hotel Lawrence.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. L. Stewart, Jefferson Hospital. Meets, first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

**RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**

*Secretary*, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

**RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

**RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.**

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

**RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

**RADIOLOGICAL SOCIETY OF NEW JERSEY**

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

**SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

**SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

**SHREVEPORT RADIOLOGICAL CLUB**

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

**UTAH RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

**UTAH STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

## X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

## CUBA

## SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

## MEXICO

## SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

## BRITISH EMPIRE

## BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

## FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

## SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

## CANADIAN ASSOCIATION OF RADIOLOGISTS

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

## SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

## SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

## RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

## SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

## RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

## SOUTH AMERICA

## SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

## SOCIEDAD PERUANA DE RADIOLOGIA

*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

## CONTINENTAL EUROPE

## SOCIÉTÉ BELGE DE RADIOLOGIE

*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

## CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

## POLISH SOCIETY OF RADIOLOGY

First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

## WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY

*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

## SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

## ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD.

USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

## LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

## MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamycin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

## SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

## SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

### THIRD INTER-AMERICAN CONGRESS OF RADIOLOGY

The officers of the Sociedad Chilena de Radiología have recently advised us that the Board of the Chilean Society of Radiology has commenced the work of organizing the Third Inter-American Congress of Radiology, and in accordance with Articles V and VII of the Statutes governing the inter-American radiological congresses, an executive committee has been appointed to organize the Third Inter-American Congress as follows:

Dr. Felix J. Daza, President  
Dr. César A. Velasco, Secretary  
Dr. Alberto F. Ricci, Treasurer

The official subjects to be covered are as follows:

Diagnosis: Radiological Exploration of the Cardiovascular System. Cranial Radiology (simple).

Therapy: Treatment of Cancer of the Mouth. Treatment of Female Genital Tumors.

The Executive Committee will choose four other subjects which will be added to these four as main topics of discussion. These eight papers will constitute the subjects of discussion in the eight ponencias. Other papers may be offered on any subject relating to radiology.

Further communications will be made from time to time as the information arrives.

JAMES T. CASE

### NEW MEXICAN JOURNAL

The AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY salutes Volume 1, Number 1 of the new *Revista Mexicana de Radiología y Fisioterapia*, the official organ of the Mexican Society of Radiology and Physiotherapy. The first number, representing the first quarter of 1947, contains an editorial by our esteemed colleague Dr. Manuel F. Madrazo.

It seems that in 1926 the first Society of Radiology and Physiotherapy was founded in Mexico. Its members included Julian Villarreal, Manuel Zubieta, Vincente Perez de la Vega, Mariano Somonte, Ulises Valdez, Gustavo Peter, in addition to Madrazo himself. A journal was started at that time and survived for several years.

The present journal before us is the Mexican response to the radiological advance movement which, though principally American, is influencing the whole world. Two Inter-American Congresses of Radiology have already been presented; the third will take place in Santiago, Chile, in 1949, and the Mexican Government has already given a special invitation for the fourth to be held in Mexico.

The principal article in this number deals with cerebral arteriography (*Arteriografía Cerebral*). The author Baudelio Villanueva is Professor of Radiology in the Faculty of Medicine and Assistant Chief of the Service in the Sanatorio Español.

The second article, by Dionisio Pérez Cosío, deals with the history, evolution and present status of cholecystography (*Historia, Evolución y Estado de la Colecistografía*). The remainder of the journal is made up of reviews of the literature.

JAMES T. CASE

### PENNSYLVANIA RADIOLOGICAL SOCIETY

At the Thirty-second Annual Meeting of the Pennsylvania Radiological Society, held on May 9 and 10, 1947, at Pocono Manor, Pennsylvania, the following officers were elected to serve for 1947-1948: *President*, Dr. Ralph D. Bacon, Erie, Pa.; *President Elect*, Dr. Leslie H. Osmond, Pittsburgh, Pa.; *1st Vice President*, Dr. George W. Chamberlin, Reading, Pa.; *2nd Vice President*, Dr. William V. Dzurek, Pittsburgh, Pa.; *Secretary-Treasurer*, Dr. James M. Converse, Williamsport, Pa.

At a recent meeting of the Executive Committee of the Society, it was decided to hold the Thirty-third Annual Meeting of the Pennsylvania Radiological Society

at Erie, Pennsylvania, on May 21 and 22, 1948, with headquarters at Hotel Lawrence.

MILEY B. WESSON, *Chairman*  
ANSON L. CLARK  
JOHN E. HESLIN

#### PITTSBURGH ROENTGEN SOCIETY

At a recent meeting of the Pittsburgh Roentgen Society the following officers were elected for 1947-1948: *President*, Dr. H. N. Mawhinney, Pittsburgh, Pa.; *Vice President*, Dr. Joseph Danzer, Oil City, Pa. *Secretary-Treasurer*, Dr. R. P. Meader, Pittsburgh, Pa.

#### UROLOGY AWARD

The American Urological Association offers an annual award of \$1000.00 (first prize of \$500.00, second prize \$300.00 and third prize \$200.00) for essays on the result of some clinical and laboratory research in Urology. Competition shall be limited to urologists who have been in such specific practice for not more than five years and to residents in urology in recognized hospitals.

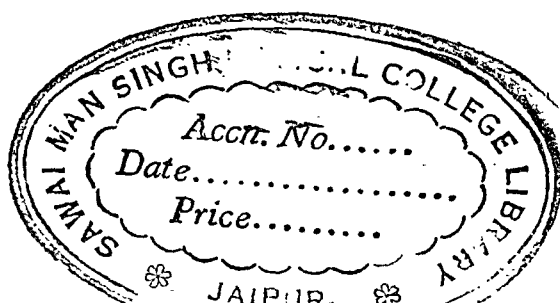
The first prize essay will appear on the program of the forthcoming meeting of the American Urological Association, to be held at the Hotel Statler, Boston, Massachusetts May 17-20, 1948.

For full particulars write the Secretary, Dr. Thomas D. Moore, 899 Madison Avenue, Memphis, Tennessee. Essays must be in his hands before March 1, 1948.

Committee on Scientific Research

#### FOOD PACKAGES FOR FOREIGN MEMBERS

The American Roentgen Ray Society has honorary members in Europe who cannot get an adequate amount of the necessities of life. A number of them have been receiving food packages from American friends, and expressions of the deepest gratitude have been received. Some individuals, however, have received many shipments and others few. Dr. Ramsay Spillman, 115 East 61st Street, New York 21, New York, has investigated the matter of food shipments, and reports that the most for the money is to be had through CARE, Incorporated. This organization has arranged to send to Europeans in want, packages of surplus food packed for use of our armed forces and stored in warehouses on the other side. Thus, none of the cost of \$10.00 per package goes for trans-seas shipping charges. Dr. Spillman will be glad to act as a clearing house for the generosity of members who would like to contribute to the relief of the distress of our foreign honorary members and to bring about a more equable distribution. Members may designate specific recipients and send packages either direct or through Dr. Spillman.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

DANDY, WALTER E. Diagnosis and treatment of strictures of the aqueduct of Sylvius (causing hydrocephalus). *Arch. Surg.*, July-Aug., 1945, 51, 1-14.

This is a congenital anomaly characterized by the replacement of the iter with glial tissue. At times there may be an incomplete stricture which allows intermittent passage of fluid. Obstruction of the aqueduct results in hydrocephalus. When the obstruction is complete the hydrocephalus produces rapid destruction of the brain. If the cranial sutures are opened or not completely closed, there is separation of the sutures with resulting enlargement of the head. Obstructions of the aqueduct of Sylvius account for about one-half of the cases of hydrocephalus in infants. In children beyond the infant age, hydrocephalus is most commonly caused by a tumor. The author emphasizes the height of the inion as a diagnostic sign. He points out that in the lateral roentgenogram, if the inion is in a low position, it is significant of obstruction of the iter rather than an obstruction at the foramen of Magendie and Luschka. The inion is also important in the differential diagnosis of posterior fossa tumors. In a case of posterior fossa tumor the inion is in a high position. It is emphasized that in many of these cases a differential diagnosis can be made on the basis of the routine skull films. In those cases in which ventriculography was done, a triangular shadow of the air in the region of the obstructed aqueduct can be seen. This air shadow tapers backward and slightly downward to a point in the mid-brain from the opening of the aqueduct in the third ventricle. It is pointed out that the ventricle must be drained completely and over-distended with air in order to see this air shadow.

The author reports his operation of ventriculostomy for the treatment of these lesions. Cures are obtained in most cases when the patient is more than a year old and, in less than half of the cases, if operated on in infancy. —George W. Chamberlin.

### NECK AND CHEST

HOLMGREN, BENGT S. Sideropenic dysphagia or cancer of the hypopharynx? *Acta radiol.*, 1943, 24, 455-461.

Sideropenic dysphagia can be revealed by roentgen examination using a special technique which Waldenstrom and Kjellberg have described in detail. The roentgen appearance is often highly typical. In this disease one or several thin, transverse mucous membranes are often found in the upper part of the esophagus immediately below the hypopharynx. During the deglutition of a large mouthful of contrast fluid these membranes cause indentations in the pillar of medium with the esophagus well distended. As a rule there is a single small membrane within the supero-anterior part of the esophagus in which case a typical relief can be seen on the lateral picture of the esophagus.

A case of cancer in the hypopharynx in a typical picture of sideropenic dysphagia is shown. The cancer was found to be entirely separate from the sideropenic change in the upper part of the esophagus.—Mary Frances Vastine.

DISANT'AGNESE, PAUL E. A., and ANDERSON, DOROTHY H. Celiac syndrome. IV. Chemotherapy in infections of the respiratory tract associated with cystic fibrosis of the pancreas; observations with penicillin and drugs of the sulfonamide group, with special reference to penicillin aerosol. *Am. J. Dis. Child.*, July, 1946, 72, 17-61.

This paper is a voluminous report of 15 cases of congenital pancreatic deficiency covering treatment of the infection of the respiratory tract found in this condition. Respiratory infection associated with cystic fibrosis of the pancreas is described with respect to the clinical course and pathologic and bacteriologic conditions.

The clinical course is marked by a more or less prolonged period of chronic cough, with exacerbations following intercurrent infections. This phase is followed by a period of cyanosis and respiratory distress of several weeks' dura-

tion terminating in death. At postmortem examination the characteristic lesion is a chronic inflammation and fibrosis of the small and middle-sized bronchi, with a superimposed acute suppurative bronchitis due to hemolytic *Staph. aureus*. The symptoms of asphyxia result from occlusion of the bronchi and trachea by mucopurulent material.

Roentgenograms of the chest during the earlier period of the disease process may show no abnormalities, but later increased bilateral bronchovascular markings are found and a diagnosis of bronchopneumonia is usually made. Roentgenograms during the terminal stages of the infection of the respiratory tract show diffuse focal "snowflake" shadows similar to those of disseminated pulmonary tuberculosis. These shadows disappear rapidly with the institution of penicillin therapy in all cases in which a good clinical response is obtained. The increase in bronchovascular markings may remain for many months even after complete disappearance of pulmonary symptoms, and then a gradual regression occurs. Their persistence seems to bear a relationship to the duration of pulmonary symptoms prior to therapy. They are interpreted as the result of irreversible or slowly reversible changes due to scarring.

In cases of a milder infection of relatively short duration the roentgenographic appearance of the lung became normal after treatment. It seems probable that in some of the patients who responded to therapy after prolonged infection the roentgenograms will show clearing after more time has passed.

The mortality of fibrocystic disease has been reduced and an increasing number of patients have been maintained in good health and in a state of normal nutrition and activity. This has been accomplished by the following means: (a) an appropriate diet, begun promptly and continued consistently; (b) the use of sulfadiazine during the stage of chronic cough, both for prophylaxis and for treatment of intercurrent infections, and (c) the use of penicillin either by inhalation alone or by inhalation combined with intramuscular injection for the treatment of the terminal suppurative bronchitis.—*R. S. Bromer*.

ALMKLOV, JOHN R., and HATOFF, ALEXANDER.  
Pneumatocele during the course of pneumonia in children. *Am. J. Dis. Child.*, Nov., 1946, 72, 521-528.

The occurrence of a cavity in the lung during the course of pneumonia in children is a frequent roentgenologic finding. The cavity has a sharply defined thin border, and in a large number of cases, an air fluid level. These cavities are variously called pneumatoceles, emphysematous bullae or benign cavities. Seven cases are tabulated in the paper. The demonstration of the condition depends on serial roentgenograms taken during the course of the disease. The mechanism consists of the check valve action of bronchiole mucosa involved in the inflammatory process of pneumonia. A pneumatocele rarely produces symptoms or signs. However, the process may become large enough and encroach sufficiently on the vital capacity to produce cough, dyspnea and cyanosis. A pneumatocele may rupture through the pleura, producing a tension pneumothorax. The differential diagnosis is simplified by the benign, ephemeral character of the lesion. In the uncomplicated case no therapy is indicated.—*R. S. Bromer*.

JONES, EDNA M., PECK, W. M., and WILLIS, H. S. Bronchiectasis following primary tuberculosis. *Am. J. Dis. Child.*, September, 1946, 72, 296-397.

Pulmonary tuberculosis in children is frequently complicated by tuberculosis of a bronchus. The bronchial disease may be present as granulomatous tissue (tuberculoma), as ulcer or merely as edema and inflammation. Tuberculous tracheobronchial lymph nodes often encroach on the lumen by pressing and at times eroding the bronchial wall. These bronchial lesions are frequently associated with obstructive pneumonitis.

A large percentage of children who have obstructive lesions associated with tuberculosis of a bronchus reveal bronchiectasis in the segment or lobe involved in the obstruction. The dilatation extends from root to periphery. In the study reported in this paper, 37 children with known, proved obstructive lesions of the type mentioned, were recalled at a mean of three and a half years after the pulmonary lesions secondary to bronchial obstruction had cleared. Bronchographic studies were made on 37 children. Of these, in 3, iodized poppyseed oil, 40 per cent, could not be placed in the previously involved areas. Of the 34 others, obvious signs of bronchiectasis were unequivocal in 24, or 70 per cent. Pulmonary tuberculosis in children

appears to be a common cause of bronchiectasis. Few of the 24 children with bronchiectasis presented conspicuous symptoms.—*R. S. Bromer.*

SUTER, FELIX. Beitrag zur Diagnose und Therapie der Bronchustuberkulose. (Diagnosis and treatment of bronchial tuberculosis.) *Radiol. clin.*, Nov., 1946, 15, 335-376.

The author reviews the general subject of disease of the bronchi in association with tuberculosis of the lungs and discusses 16 cases of his own. The sexes were about equally involved. Seven of the patients were men and 9 women. In 14 of the cases the disease of the bronchi was tuberculosis while in 2 cases the bronchi were only mechanically distorted by tuberculous cirrhosis of the lungs and pneumothorax treatment. Of the 14 cases of tuberculosis 13 were mural and 1 extramural. In 15 cases there was stenosis of the bronchi, in some associated with ulceration. In only 1 case was there ulceration without stenosis. With the exception of the one case of extramural tuberculosis the process was in the left chief bronchus in all cases.

All of the patients had first suffered from an open pulmonary tuberculosis which for the most part showed a tendency to heal and only caused death in 2 cases. There was no parallelism between the severity and extent of the pulmonary tuberculosis and the disease of the bronchi; in one case the ulcers of the bronchial mucous membrane healed in spite of rapid progress of the lung process. The disease of the bronchus is not serious in itself, but the results of the stenosis, such as fibrosis of the lung, bronchiectases, retentions, pleurisy and empyema are often very severe.

The diagnosis of tuberculous tracheobronchitis can be made by careful roentgen examination. The use of hard rays and tomography are particularly valuable. The cases are illustrated with roentgenograms and tomograms. Treatment is chiefly endobronchial and consists of cauterization, diathermia and removal of the secretion.—*Audrey G. Morgan.*

CHRISTIE, AMOS, and PETERSON, J. C. Pulmonary calcification and sensitivity to histoplasmin, tuberculin, and haplosporangin. *J.A.M.A.*, June 22, 1946, 131, 658-660.

In certain sections of the United States there is a large percentage of individuals who have pulmonary calcifications. Studies by various workers have shown that about half of these individuals have negative reactions to tubercu-

lin tests. Most of the studies showing this disproportion were done on young individuals living in or adjacent to the western Appalachian Plateau, or the eastern or western slopes of the Mississippi River basin. Coccidioidomycosis has been shown to produce such pulmonary calcifications. Also, histoplasmosis has produced calcifications in the lungs of many individuals with negative tuberculin tests.

The authors have previously reported a benign form of histoplasmosis and have noted that many patients reacted to an extract of this fungus. In this report they discuss studies done on 344 children between the ages of five and nineteen years. The presence or absence of pulmonary calcification was determined from stereoscopic 4×5 inch films. The cutaneous reaction to old tuberculin, to histoplasmin (from *Histoplasma capsulatum*), and to haplosporangin (from *Haplosporangium parvum*, a fungus pathogenic for certain rodents) was determined.

Fifty-three per cent of the children had intrathoracic calcifications and only 21 per cent reacted to tuberculin. On the other hand, 73 per cent reacted to histoplasmin. None reacted to haplosporangium. Also, more children had calcification in the absence of sensitivity to tuberculin than had it in conjunction with sensitivity to tuberculin.

In the 27 children in the youngest age group, one child was sensitive to old tuberculin and 13 showed calcification. Nineteen of the 27 were sensitive to histoplasmin. In the oldest age group, there was a higher percentage of children with positive tuberculin tests while the other factors maintained the same general relationship.

The age at which sensitivity to histoplasmin develops and that at which calcification develops are in such a relationship that they might be directly associated. The age at which sensitivity to tuberculin appears lags so far behind that for deposition of calcium in the lung or hilum that it would not seem to have the same degree of association.

The authors feel that a considerable number of individuals in the areas studied have pulmonary calcification due to infection with *Histoplasma*.—*E. F. Lang.*

BRUCE, TORSTEN, and JÖNSSON, GUNNAR. The roentgen picture of silicosis in different industries. *Acta radiol.*, 1943, 24, 89-112.

It is the experience of these authors that while silicosis takes different lengths of time to

develop in different persons in the same work its roentgenologic picture is always the same in the same industry. In a number of instances the silicotic roentgenologic picture was so characteristic that the authors were able to tell the occupation of the patient without knowing anything of the history.

The special features of each occupation are largely dependent upon the following factors: (1) the prominence of the striation in comparison with the mottling; (2) the shape, delimitation, relative size and situation of the discrete nodules; (3) the situation of the massive lesions and the emphysematous areas. (In advanced silicosis the lateral chest roentgenogram gives valuable information on the borderline between the section of the lung where the consolidation dominates and where the emphysema takes the upper hand.)

1. Porcelain workers. There is a "soft" appearance to the pulmonary picture. It lacks contrast. Thus the striations are prominent while the nodules are not well outlined or of marked density. The emphysematous areas are situated anteriorly and inferiorly while the clouded parts are in the upper and posterior portions. The borderline between these areas is not distinct.

2. Molders in steel foundry. The nodules are better defined and denser than in porcelain silicosis. They lie laterally and apically and envelop the central clearer portion like a mantle. Egg-shell calcification of the hilar shadows may appear later.

3. Steel cleaners. In the first and second stages the mottling dominates over the striation. The nodules are dense as in the foundry workers. However, there is no predilection for the lateral parts as in the foundrymen.

4. Furnace masons in steel work. Mottling dominates over reticulation and the nodules are situated as are those of the foundrymen. No egg-shell shadows in the hilar regions have been seen.

5. Workers in silicon alloys. The silicotic picture in this occupation most closely resembles that of the porcelain workers. However, the nodules seem slightly more dense.

6. Sandstone cutters. The massive consolidations do not form large homogeneous blocks but there are numerous, up to almond sized, closely packed shadows situated mainly in the middle and basal lung fields.

7. Workers in quartz mines. Nodulation predominates. They are situated most prominently in the middle lung fields. The massive consolida-

tions are in the lower parts of the middle fields or even basilar.

8. Workers in quartz mills. The linear markings dominate over the mottling. The nodules are scattered everywhere but have a predilection for the infraclavicular regions. The centers for contraction are situated dorsally at the apex of the lower lobes.

9. Workers in iron ore mines. There are practically no linear markings. The spots are very dense and evenly distributed. These nodules are about equal in size. Occasionally egg-shell calcification of the lymph glands is seen. In the third stage the massive blocks lie dorsally and laterally. They are much more irregularly situated, however, than in the cases of silicosis in other industries.—*Mary Frances Vastine.*

OLKEN, HARRY G. Congenital gastro-enteric cysts of the mediastinum. *Am. J. Path.*, Sept., 1944, 20, 997-1009.

Congenital gastric and enteric cysts of the mediastinum are rare. Cystic tumors of the mediastinum are usually congenital and include dermoid and teratoid tumors, pericardial celomic cysts, cystic lymphangiomas, the so-called bronchogenic cysts and gastro-enteric cysts. The latter are lined with mucous membrane resembling some portion of the gastrointestinal tract.

The author reports a case of a full-term, male, still-born fetus showing numerous congenital defects, including a large gastro-enteric cyst which occupied most of the right thorax. Microscopically, the cyst wall was composed of distinct muscle layers and varying amounts of lymphoid tissue. The mucosa varied from a simple layer of cuboidal, non-ciliated epithelium a single cell in thickness to a well differentiated gastric lining in which mucus-secreting glands and acid-secreting cells were identified.

The author reviews the literature and summarizes eighteen well defined cases of gastro-enteric cysts of the mediastinum. They occur more in males than in females and are found predominantly in the right hemithorax. Most striking is the early age at which symptoms are produced. Seventy-five per cent of the cases were discovered within the first year of life and in only 2 instances were the children as old as three years. This is in sharp contrast to the mediastinal dermoid tumors which produce practically no symptoms until after the first decade of life. Sixteen of the 19 cases analyzed showed other congenital anomalies. The skeletal

and intestinal tracts were most frequently involved.

The knowledge of these mediastinal anomalies and the improvements on the techniques of thoracic surgery have permitted some hope of successful therapy. In 7 instances surgical removal was attempted, and in 3 instances the operation was successful and recovery complete.

A discussion as to the possible embryological origin of these cysts, as well as of esophageal and bronchogenic cysts, is presented. Three explanations are offered for the genesis of the enteric and gastric cysts: (1) to the pinching off of a bud or diverticulum of the embryonic foregut; (2) to an intrathoracic remnant of the omphalomesenteric gut, and (3) to an embryonic diverticulum or epithelial remnant capable of producing intestinal or gastric mucosa.—*Harry Hauser.*

COTTET, P. La problème radiologique du volume cardiaque et l'application à la clinique de la méthode de Ludwig. (Roentgen problem of the cardiac volume and the application to the clinical findings of the method of Ludwig.) *Radiol. clin.*, March, 1946, 15, 134.

Among the different roentgen methods the theoretical and practical value of which in determining the volume of the heart is under discussion, preference is given to frontal and profile orthodiagraphy. Ludwig's method for obtaining the real volume of the heart is described with simplifications which render its use simpler and more rapid, such as inscription of the diameters used on transparent films and a rule for use in calculating the volume.

The different conditions which modify the size of the heart are discussed. The results of measurements of 104 individuals of both sexes are given. Some of them were heart patients and some were not. There was remarkable agreement between the clinical and roentgen findings among the men, while the probable sizes among women, calculated in relation to body weight, were generally too small. It was found that the

quotient  $\frac{\text{width of the thorax}}{\text{transverse diameter of heart}}$ , which

normally varies from 1.66 to 2.46, is of little value. The heart volumes for men were from 426 to 760 cc. and for women 394 to 528 cc. The largest volume among the heart patients was 1,730 cc., which is an enlargement of 138 per cent. Diseases accompanied by malnutrition brought about a decrease in the size of the

heart. The method is indicated for the diagnosis of cases at the limits of normal and to follow the development of a heart disease during treatment.—(author abstract translated by *Audrey G. Morgan.*)

STEINMANN, B., and DEUEL, H. D. Az. H. Beitrag zum entzündlichen Perikarddivertikel. (Inflammatory diverticulum of the pericardium.) *Radiol. clin.*, Nov., 1946, 15, 315-322.

Textbooks of pathology generally consider diverticula of the pericardium only among congenital malformations but there are acquired diverticula of the pericardium and such a case, resulting from pericarditis, possibly tuberculous in origin, is described. The patient, born in 1918, showed normal heart findings on roentgen examination in 1938. In 1942 he had a cold and felt a stabbing pain in the chest on breathing. He also had a feeling of constriction in the heart region and palpitation on effort. From 1939 to the spring of 1945 he was on active military service; at that time a routine roentgen examination showed a saccular structure with a calcified wall applied to the heart shadow anteriorly and on the right side. He had had no clinical symptoms. This was diagnosed as a pericardial diverticulum. It had no visible communication with the rest of the pericardium. Apparently the exudation pressed against a weak area in the pericardium that was surrounded by adhesions and resulted in a cavity filled with fluid the walls of which became calcified and made roentgen diagnosis much easier. This calcification explained the failure of the diverticulum to change its form on heart action, respiration and change in position of the body. Roentgenograms of the case are given.—*Audrey G. Morgan.*

GROSS, ROBERT E. Congenital hernia of the diaphragm. *Am. J. Dis. Child.*, June, 1946, 71, 579-592.

In his summary, Gross states that most congenital defects of the diaphragm can be repaired by surgical means, regardless of the small size of the patient or of a high degree of respiratory embarrassment. Abdominal viscera may be extensively displaced into the chest, but it is possible to return these to normal positions and to reconstruct the diaphragm in a suitable manner. The disturbance of pulmonary function may be severe enough to threaten the life of the patient, yet relief can be quickly obtained

by the operative removal of foreign organs from the thorax and by the immediate expansion of the lungs.

The detection of a congenital diaphragmatic hernia is not difficult. The condition may not make itself manifest for several months or years after birth, but in the majority of children the respiratory or alimentary disturbances are severe enough to be brought to the physician's attention in the neonatal period. Physical examination of the chest usually results in observations which are sufficient to suggest the presence of the hernia.

Roentgenologic studies are of value in detecting or in confirming the presence of a diaphragmatic herniation and they give some idea of the extent of the intrathoracic derangements. In the majority of cases, Gross believes, all the necessary data can be gleaned from anteroposterior and lateral roentgenograms, taken preferably with the patient in an upright position. These will indicate the over-all size of the hernial mass, the state of compression of the lungs and the position of the heart. From a practical point of view, this is all the surgeon needs to know. He regards the examination of the patient's gastrointestinal tract roentgenologically after the ingestion of a barium sulfate meal or after a barium enema to ascertain just what viscera are in the chest as superfluous. Such data will not in any way alter the operative procedure, but the barium will further fill the alimentary canal and add to the surgeon's difficulties at the operating table. Patients with esophageal hiatus hernias, however, can be advantageously studied roentgenologically after ingestion of a barium meal, for much can be learned thereby about the local anatomic abnormalities. The length of the esophagus can be accurately determined. It is also possible to see how much of the stomach resides above the level of the diaphragm and whether it is constricted as it passes through the diaphragmatic opening. Finally, one can get a clear idea of the presence or absence of obstruction in the stomach or duodenum.

In a rare case of a child with herniation into the pericardial sac, roentgenograms and fluoroscopic studies gave pertinent information but did not conclusively prove the presence of a hernia.

Except for the less troublesome types of hernia, such as those occurring at the esophageal hiatus and those with a small sac, a diagnosis of diaphragmatic hernia should be followed promptly by surgical correction of the de-

formity. This is certainly true for newly born babies with cyanosis or respiratory distress.—*R. S. Bromer.*

#### ABDOMEN

RAMSEYER, MARC. A propos d'une tumeur pédiculée de l'estomac présentant tous les caractères radiologiques d'une tumeur bénigne. (A pediculated tumor of the stomach showing all the roentgen characteristics of a benign tumor.) *Radiol. clin.*, March, 1946, 15, 69-74.

A case is described in a woman of sixty-eight who was admitted to hospital Dec. 24, 1944, with a diagnosis of hemorrhage from a gastrointestinal tumor. Neither the clinical symptoms nor pathological examination indicated malignancy. Roentgen examination on admission also showed the signs of benign tumor of the stomach—a more or less rounded tumor with distinct outlines, mobile, with normal mucous folds and normal peristaltic waves passing along the two curvatures. The passive mobility of the stomach was normal. There may even be an ulcerous niche on a benign tumor although there was none in this case.

Operation revealed a pediculated tumor on the posterior wall of the stomach which was shown on examination to be a glanduliform epithelioma.

The author therefore agrees with those authorities who claim that there are no pathognomonic signs of malignancy in tumor of the stomach. Since benign tumors of the stomach may undergo malignant degeneration it seems logical that there would be no change in the tumor visible on roentgen examination, at least not in the early stages of the malignancy.—*Audrey G. Morgan.*

HOLTA, OLAV. Leiomyosarcoma ventriculi; three cases. *Acta radiol.*, 1943, 24, 166-173.

Three cases of leiomyosarcoma of the stomach are reported. Each patient was a male, aged twenty-eight, fifty-five and sixty-five years of age, respectively.

*Etiology.* Apparently there is no certain sex predisposition. The average age incidence is forty-five to fifty years. In some cases there is a history of trauma (not in these 3 cases).

*Pathology.* The exogastric forms usually become very large and form cystic cavities that break through to the peritoneal cavity with subsequent peritoneal metastases or peritonitis.

The endogastric forms develop submucosally.

The mucous membrane remains intact for some time and then becomes necrotic with the formation of ulcers. These tumors are often polypoid and have a broad base. They are seen most frequently on the greater curvature.

The intramural forms are the rarest. They form diffuse thickenings in the muscularis. They metastasize to the perigastric lymph nodes or the liver. Metastases are late.

*Symptoms.* These are not characteristic and are often those of ulcer.

*Roentgen Picture.* There are no distinguishing features between these tumors and other gastric growths. Kessler maintains that a diagnosis of the exogastric form should be made when a tumor on a broad base is found attached to the serosal side of the stomach wall.

*Prognosis* is good if no metastases are demonstrable. The prognosis is considerably better than that for carcinoma or for the other forms of sarcoma.—*Mary Frances Vastine.*

HUDSON, PERRY B., GAY, LENDALL C., and NEWMAN, HOWARD E. Pneumothorax resulting from a dissecting gastric ulcer. *Arch. Surg.*, June, 1945, 50, 301-303.

The authors review the literature and find 25 cases of acquired gastrothoracic fistulas developing from peptic ulcers. None of these cases were in the acute type of ulcer which was noted in the patient reported in this article. This patient was a sixty-nine year old white man who was admitted with severe epigastric and general abdominal pain. He had indigestion for fifteen years, but there was no clear cut history of ulcer or gallbladder disease prior to his recent illness.

Examination showed a mild degree of shock, some involuntary rigidity of the entire abdomen, and tenderness in the upper abdomen. Physical examination of the chest did not reveal anything abnormal. The film of the chest with the patient in bed showed a partial collapse of the left lung due to pneumothorax. A clinical diagnosis was not definitely arrived at and the patient died fourteen and one-half hours after admission.

Postmortem examination showed acute gastric ulcer on the posterior aspect of the cardiac end of the stomach with erosion into the wall of the stomach and upward into the wall of the esophagus causing dissection of the wall with perforation of the esophagus into the left pleural cavity.—*George W. Chamberlin.*

BABAIANTZ, L., and MACH, R. S. Sémeiologie radiologique de la sténose hypertrophique du

pylore chez l'adulte. (Roentgen symptomatology of hypertrophic stenosis of the pylorus in the adult.) *Radiol. clin.*, March, 1946, 15, 125-129.

Stenosis of the pylorus in the infant offers no difficulty in roentgen diagnosis; it is only a question of differentiating between simple pylorospasm and organic occlusion by the time and rhythm of the passage of the contrast medium.

But in the adult the diagnosis is somewhat more difficult. It is discussed in connection with a case in a man of forty-four who had had dyspeptic symptoms since he was twenty-four. In 1942 the authors made a roentgen examination which showed a tubular stenosis of the pyloric canal with semi-rigid walls. The caliber of the canal varied slightly in different areas and the borders were for the most part smooth. The canal was apparently elongated from invagination into the base of the bulb of the duodenum. There was no occlusive pylorospasm. The passage was slowed; there was a residue of barium of about four fingers breadths three hours after the meal was given. There was hyperkinesia back of the stricture. The roentgenograms showed deep circular prepyloric contractions. There was no image of gastroduodenal ulcer. Operation was proposed and refused but as his symptoms grew worse the patient returned in 1944. The appearance of the stenosis was practically the same but there was an ulcer niche on the lesser curvature at the level of the sinus. For this reason the patient consented to operation which showed hypertrophy of the wall of the pyloric canal for about 8 mm. with no anatomical relationship with the peri-ulcerous lesions. The mucous membrane of the canal was intact, an important sign in differentiation from cancer. The author believes the ulcer was secondary to the stenosis. Roentgenograms of the stenosis and a microscopic picture of the hypertrophy of the musculature are given.—*Audrey G. Morgan.*

KRAFT, MATHILDE. Subseröse verkalkte Drüse in der Magenwand. (Subserous calcified gland in the wall of the stomach.) *Radiol. clin.*, Sept., 1946, 15, 280-283.

A man of sixty-five came for examination of the gastrointestinal tract. He had often had pain in the stomach since he was eighteen years of age. He was pale and emaciated. Roentgen examination showed a shadow the size of a thumb-nail on the greater curvature of the



stomach in the region of the fornix. On turning the patient it moved with the stomach wall. When the patient was turned head downward it indented the filled fornix region. It showed no contractions and remained the same size throughout the examination and on subsequent examinations. A diagnosis was made of inflammatory tumor in the ileocecal region and operation was performed which showed an abscess around the appendix. The patient died five weeks later of a heart attack.

Microscopic examination showed a calcified nodule lying beneath the serosa of the stomach at the site of the roentgen shadow; it was surrounded by a hard sclerotic capsule and showed extensive calcification. Though no normal lymphatic tissue could be demonstrated in it, it was probably a calcified lymphatic gland, in which calcification had resulted from central necrosis.

Small lymphatic glands may occur normally in the subserosa of the stomach wall and may cause obscure pathological conditions such as acute interstitial abscesses of the stomach wall, circumscribed phlegmonous inflammations, and so forth.—*Audrey G. Morgan.*

LADD, WILLIAM K., WARE, PAUL F., and PICKETT, LAWRENCE K. Congenital hypertrophic pyloric stenosis. *J.A.M.A.*, June 22, 1946, 131, 657-661.

The authors report 1,145 cases of congenital hypertrophic pyloric stenosis seen in the Children's Hospital in Boston and they emphasize 380 cases seen between 1939 and 1945.

As reported in most other series, they found the disease most commonly in the first born, in males, without relation to race (they felt that any racial preponderance could be correlated with the same preponderance in the group from which the patients were selected), and often occurring in families. They believe that the condition occurs because of work hypertrophy of the pyloric muscle as it attempts to overcome pylorospasm which was present at birth. Further irritation from hyperperistalsis results in edema of the pylorus. Microscopically, hyperplasia and hypertrophy of the muscle are seen combined with mucosal edema.

The babies usually begin vomiting in the second or third week of life and are underweight and dehydrated by the time they are usually seen. They are always hungry. The feces are small and dry not from constipation but from lack of food. Vomiting is frequently

severe enough to cause hyperpnea and even convulsions from alkalosis. Observation of peristaltic waves through the abdominal wall may lead to the most important finding: the demonstration of an olive-sized mass in the right upper quadrant. This was found in 98 per cent of the cases in this series.

The roentgenographic findings are (1) gastric dilatation, (2) intermittent hyperperistalsis, (3) a greatly elongated pyloric canal which is only 2 to 3 mm. in width, and (4) delayed gastric emptying.

The condition is to be differentiated from pylorospasm which is intermittent, from infectious vomiting, improper feeding, intracranial injury, relaxation of the cardia (chylasia), and intestinal obstruction, either from intrinsic causes, as duodenal stenosis, or extrinsic causes, as malrotation or volvulus.

Pre- and post-operative care are described in detail. The authors advise separation of the pyloric muscular fibers down to the mucosa. A rare complication of this pyloromyotomy is perforation of the duodenum. In the 380 cases otitis media was seen in 6.3 per cent, infection of the wound in 3 per cent, evisceration in 0.8 per cent, pneumonia in 2.4 per cent and malrotation in 1.3 per cent.

The operative mortality was 4 per cent in 380 cases and there were no deaths in the last 225 patients in the series.—*E. F. Lang.*

HELLMER, HANS. The roentgenologic diagnosis and treatment of intussusception in children. *Acta radiol.*, 1943, 24, 235-258.

Between June 1, 1933, and December 31, 1942, 335 cases were examined with barium enemas and in 110 cases, covering 93 patients, the diagnosis of intussusception was made. Roentgenologic reduction was attempted in all the cases. Of the 93 patients 57 were boys and 36 girls. All but 10 patients were under four years of age, more than a third were in their first year.

*Roentgenologic Diagnosis.* The author divides intussusceptions into two types: (1) invaginations starting in the mucous membrane of the large intestine and (2) invaginations starting in the mucous membrane of the small intestine.

In 51 of the 58 cases in which the site of origin of the intussusception was established it was found to lie in the small intestine.

The author makes the following points:

1. Non-operative reduction of the intussusception (i.e. reduction with the barium enema)



can very well be used for intussusception starting in the small intestine. In the case of intussusception starting from the small intestine where complete reduction is not effected, the partial reduction produced simplifies the subsequent operation by calling for only a small incision in the abdomen. (The author fills the small intestine refluxly when doing the barium enema—in all cases.)

2. One criticism of the method is that a retrograde intussusception is made worse by it. The author feels this is of no great practical importance inasmuch as retrograde intussusception is rare.

3. After the author made it a rule that the barium enema go high up in the small intestine before the reduction be pronounced complete, there have been no incomplete reductions of the intussusceptions.

4. It has been said that it is not possible to know how severely the large intestine is injured and that therefore the intestine may break under pressure of the enema. The author admits that this statement is correct but he adds that there has been no case of perforated intestinal wall in his material.

5. The fact that one does not know whether the disinvaginated intestine can continue living is an unavoidable limitation of the roentgenologic method.

6. Another criticism of the method is that the cause of the intussusception is not determined by the roentgen method of reduction. Hellmer states that local pathological changes in the intestinal wall can be diagnosed without difficulty roentgenologically. On the other hand, it is a well known fact that small, soft processes arising in the mucosa may be overlooked by the surgeon. It is best to remove lesions of this kind during a symptom-free interval.—*Mery Frances Vastine*.

LENOIR, ANDRÉ. Diverticule du bulbe duodénal. (Diverticulum of the bulb of the duodenum.) *Radiol. clin.*, Sept., 1946, 15, 288–294.

The author believes that the most unusual site for diverticulum of the duodenum is on the bulb. He has found only a very few cases of this localization in the literature. He saw such a case in a man of forty-one, diagnosed by roentgen examination, which is the only certain means of diagnosing these diverticula, and confirmed by operation.

The patient had had dysentery in Russia in

1942 and in Servia in 1944. He had been injured twice during air raids and after the second attack had copious vomiting and severe headache but no hemorrhage. When he came to the author for examination in May, 1945, he still had vomiting and intense abdominal pain. Treatment had no effect on either. Roentgenoscopy showed the bulb of the duodenum slightly deformed, of average size. It emptied rapidly. On the anterior wall there was a large niche; a small pedicle passed from the bulb to what was diagnosed as a diverticulum. This diagnosis was confirmed by laparotomy which showed a typical pulsion diverticulum near the pylorus with a recent peptic ulcer on the anterior wall of the duodenum. It was the ulcer that caused the pain. Pulsion diverticulum of the duodenum rarely causes pain.

The picture is not always as clear as this. In making such an examination a roentgenogram should first be made without contrast in order to eliminate any confusing shadows. Roentgenoscopic examination should then be made in various projections, turning the patient as the examination is made. Roentgenograms should be made after six, twelve, twenty-four and forty-eight hours. By that time the duodenum will be empty and barium will remain only in the diverticulum. Roentgenograms must be made in several positions in order to detach the diverticulum from the duodenum.—*Audrey G. Morgan*.

MELLINS, HARRY Z., and MILMAN, DORIS H. Congenital duodenal obstruction. *Am. J. Dis. Child.*, July, 1946, 72, 81–88.

Two cases of congenital duodenal obstruction are reported in which roentgenologic localization was verified at operation and postmortem examination. The use of injected air is recommended because of several advantages. The possibility of aspiration pneumonia and of mechanical obstruction of the intestines, which exists when barium sulfate is used, is eliminated. In the absence of air elsewhere in the bowel, air provides an excellent contrast substance which clearly outlines the location and extent of the patent bowel.

After plain roentgenograms of the abdomen are taken, a Levin tube of a size for infants is passed into the stomach and the gastric contents are aspirated. Air, the contrast medium employed, is then introduced slowly under fluoroscopic observation. Sixty to 90 cc. is

usually sufficient to produce satisfactory filling of the stomach and the upper portion of the intestine. The infant is rotated to the left under the fluoroscopic screen so that the course of the posteriorly situated duodenum can be traced. Spot roentgenograms are taken in such positions as are found to project the duodenum most advantageously. At the conclusion of the procedure, air which has not already been eructated is removed by aspiration, and the tube is withdrawn. The differentiation of complete obstruction from minimal patency may be aided by serial roentgenograms at hourly intervals which are studied for evidence of progression of the air through the bowel.

The first case which is reported was one of atresia of the duodenum. The second patient was operated upon and later died, the post-mortem examination showing obstruction due to a kink at the duodenojejunal junction with a volvulus of the entire small bowel due to rotation of the mesentery around its root.—*R. S. Bromer.*

KNOX, GRAHAM. Lymphosarcoma primary in the appendix. *Arch. Surg.*, June, 1945, 50, 288-292.

Primary lymphosarcoma of the appendix is a rare condition. The author reviewed 23 cases from the literature and reports one of his own with photographs of the gross and microscopic appearances of the lesion. The case report was that of a four year old boy who was thought to have a perforated appendix with a peri-appendiceal abscess prior to operation. On operation a sausage shaped appendix was found which was 9.5 cm. in length and 1.8 cm. in thickness. There were no demonstrable nodes in the mesentery except one small one in the inferior ileocecal fold. A simple appendectomy was done. Fifteen months after discharge the patient was essentially asymptomatic.

The microscopic examination showed lymphosarcoma.—*George W. Chamberlin.*

STEINERT, RAGNAR; HAREIDE, INGVAR, and CHRISTIANSEN, THOROLF. Roentgenologic examination of acute appendicitis. *Acta radiol.*, 1943, 24, 13-37.

The authors have studied a series of 104 cases of acute appendicitis examined roentgenologically and verified at operation for the purpose of elucidating the importance of the roentgen examination in this disease. In 80 of

the 104 cases the roentgen examination demonstrated an abnormality.

Concretions in the appendix were demonstrated roentgenologically in approximately 10 per cent. Approximately one-third of 31 cases of appendiceal concretions found at operation were demonstrable on the roentgenogram. In all of the cases with roentgenologically demonstrable concretions a gangrenous or perforated appendix had been present previously or was present at the time.

Cases of appendicitis located laterally or retroceally frequently showed a typical roentgenologic picture and in some cases could be located roentgenologically. According to Laurell a local density lateral to the cecum may represent a perforated appendix with incipient peritonitis. A similar picture may also be observed in a small appendiceal abscess lying laterally or retroceally. The authors have seen similar roentgenograms in ordinary gangrenous, non-perforated appendicitis.

The acute appendix is not always characterized by a marked accumulation of gas in the cecum. The cecum, as well as the rest of the large gut, may be empty of gas in some cases.

Fluid levels in the cecum were a frequent and characteristic finding. The more intensive the inflammation, the more often fluid levels were seen.

Gas and fluid levels in the small intestines were also a frequent finding and these were localized, for the most part, to the terminal ileal loops. Diffuse and local gas with fluid levels was observed most often in perforated appendicitis. Diffuse and local gas without fluid levels was seen most often in gangrenous or catarrhal appendicitis.

Reduced excursion of the diaphragm on the right side was seen in all grades of appendicitis. Changes in the pulmonary parenchyma or pleural effusion was seen rarely.

An effaced right flank stripe was observed in the greatly inflamed, usually the perforated, cases of appendicitis which were lateral in position.

Effaced right-sided psoas shadow and left-convex lumbar scoliosis were observed in all grades of acute appendicitis.

A typical roentgenologic picture of acute appendicitis may be seen four and a half hours after the onset of the attack. On the other hand, a perforated appendix need not give a roentgenologic picture even ten hours after the attack.

The more marked the pathologic anatomical process in the appendix the more frequent is there a negative roentgenologic diagnosis.

*Conclusion.* The roentgen examination has frequently been the means of excluding other possibilities in cases of doubt and in a few cases, in which the surgeon was uncertain, the roentgenologic findings have been of decisive importance to the operative intervention. In the great majority of cases, however, the clinical diagnosis was definite beforehand, and in 24 cases the patient was operated on in spite of negative roentgen findings.—*Mary Frances Vastine.*

FORSSMAN, G. Die Röntgendiagnostik benignen Magentumoren. (Roentgen diagnosis of benign gastric tumors.) *Acta radiol.*, 1943, 24, 135-165.

Thirty cases of benign gastric tumors (11 of simple polypi, 6 of polyposis, 3 of papilloma, 8 of myoma, 1 of neurinoma and 1 of cavernous hemangioma) have been examined at St. Gorans Hospital in Stockholm over a period of ten years. The incidence, appearance, symptomatology and clinical and roentgen pictures of the benign gastric tumors are reviewed. The main emphasis of the investigation is laid on a comparison between roentgen picture and operative findings. The appearance of the tumor defect in the different kinds of benign gastric tumors is surveyed, particular attention being paid to a study of the mucous membrane over the tumor itself. The myomas exhibited evenly rounded surfaces, covered by intact, movable mucosa, although in some cases they showed large craters. The papillomas had papillomatous surfaces while the hemangioma was softly indented with typical accumulations of phleboliths in the cavernous spaces. The movability of the tumor in relation to the mucous membrane and the muscular wall, the compressibility of the soft tumors and the appearance of the peristalsis and of the relief outline of the neighboring mucous membrane were studied.

The relatively common occurrence of malignant proliferation, particularly of papillomas and simple polypi, the combination with pernicious anemia, as well as the differential diagnosis, are discussed. In a few cases, gross examination of specimens during and after operation disclosed no signs of malignancy and the diagnosis of malignancy based on micro-

scopic examination came as a surprise. Obviously it is even more difficult for the roentgenologist in such cases to make a correct diagnosis than for the surgeon.

The tumors in question were treated surgically and resection was found to be preferable to extirpation, at least in the case of the papillomas.—*Mary Frances Vastine.*

SAWYER, C. F. Cysts of the urachus. *Arch. Surg.*, March, 1945, 50, 174-176.

All pathologic conditions of the urachus are basically congenital. The urachus may be completely patent at birth through its entire length, or there may be some degree of patency along any portion of its course. When both the umbilical and vesicle end are closed, the "blind" type is formed. This may result in a cyst. Most of these cysts are small and confined to anterior abdominal wall and/or near the midline. Sometimes the diagnosis of these cysts is very difficult because of the distortion which may be present. If the epithelial lining has been destroyed, there will be no distinctive features of the wall of the cyst. The authors report a case of an adult male with a large cyst which at operation was just beneath the anterior abdominal wall. Inferiorly, it was attached to the dome of the bladder by a firm pedicle. It was also attached to the sigmoid colon and there was evidence of a fistulous tract between the sigmoid and the cyst. This may have been a factitious fistula, possibly produced by erosion of an inflamed diverticulum of the sigmoid into the cyst.

Microscopic examination of the wall of the cyst showed dense fibrous tissue. This cyst was believed to have been urachal in origin because of its anatomic relations.—*George W. Chamberlin.*

DMYTRYK, EUGENE T. Congenital malformations of the anus and rectum. *Arch. Surg.*, May, 1945, 50, 253-257.

Anomalies of the anus and rectum are classified into four types as follows: (1) incomplete rupture of the anal membrane or stenosis at a point 1 to 4 cm. above the anus; (2) imperforate anus with obstruction due only to a persistent membrane; (3) imperforate anus with the rectal pouch separated from the anal membrane. The rectal pouch may end blindly, either in or above the pelvis; (4) normal anus and rectal pouch with the rectal pouch ending

blindly. There may be either a membranous obstruction between or a separation of the anal and rectal pouches. When the pouches are separated, a cord of tissue without a lumen occasionally may connect them.

Fifteen patients are included in this study. Of these 15, five have anomalies of type 1 and ten of type 3. Type 2 and 4 anomalies were not found in this series. Five of the 15 patients have fistulous tracts connecting the rectum with the genitourinary tract or the perineum. Five patients had other associated congenital anomalies. These included absence of the gallbladder, horseshoe kidney, hydronephrosis, and hydro-ureter, patent ductus arteriosus, anomalies of the ureter, hypospadias, unusually large foramen ovale, and mongolism.

The symptoms presented by the patients varied according to the type of anomaly and the presence or absence of associated fistulous tract.

The type 1 patients showed an anal opening which ranged from 1 to 5 mm. in diameter. Type 3 patients showed a variety of physical findings. In some the anal area had a dimple; in others there was no ridge or dimple in the median raphe to denote the normal anal site.

Roentgenographic studies were made in 9 of the 15 patients. In the group 1 cases the roentgen examinations consisted of either an abdominal film or, as in one case, a film after the injection of barium through the constricted rectum. These studies showed pronounced dilatation of the colon above the constricting lesion. The patients in group 3 had roentgen studies to ascertain the position of the blind end of the sigmoid colon. Two of these patients had an abdominal film in the upright and also in the inverted position. It is pointed out that such studies are only of value after twenty-four hours when a sufficient amount of gas has formed to fill the intestines. Giving a barium meal is contraindicated in these patients. In 2 of the patients, barium was injected into the distal loop of a double barrel colostomy, for the visualization of the blind end.

Treatment of the type 1 anomaly was either rectal dilation or plastic operations for repair of the anus. In the type 3 anomaly the treatment depended upon the presence or absence of obstructive symptoms. If no obstructive symptoms were present, primary perineal operation was done. When obstructive symptoms were present, colostomy was performed, followed by perineal plastic operation if the patient survived

the original operation. Seven of the patients who had type 3 anomalies died following operation.—*George W. Chamberlin.*

MICHELSON, ELLIOTT. Syndrome of trauma to the psoas muscle. *Arch. Surg.*, Feb., 1945, 50, 77-81.

This is a discussion with a single case report of injuries to the psoas muscle. Cases of this type are unusual. The clinical picture is one of sudden intense pain in the lower portion of the abdomen, flank, and hips, often accompanied by a knocking sound which is said to be characteristic of a rupture of a tendon. This pain usually disappears for a time and subsequently returns. The examination reveals flexion contracture of the thigh with adduction and external rotation. There is a scoliosis of the lumbar vertebrae away from the affected side and apparent shortening of the leg on the affected side. A mass or fullness may be found in the flank. In the case reported herein, there was evidence of displacement of the kidney as seen on the pyelogram. This displacement was found to be due to an infected hematoma involving the psoas muscle. The patient recovered following drainage of the abscess.—*George W. Chamberlin.*

BULLARD, ROCKWOOD W., JR. Subcutaneous or extraperitoneal gallbladder. *J.A.M.A.*, Dec. 1, 1945, 129, 949.

The author reports the finding of a gallbladder which lay directly beneath the skin and on top of the abdominal muscles without evidence of a hernial sac, a condition apparently not duplicated in medical literature.

The patient was a woman, aged eighty-one, who complained of a painless mass in the right upper abdomen which had grown during the previous two years. She had always been in good health and had never had indigestion, pain associated with eating, or jaundice. The mass appeared beneath her ribs two years before, gradually increased in size, and grew more rapidly in the last year.

A preoperative diagnosis of fascial sheath tumor was made and the mass removed under local anesthesia. The tumor was found lying on the internal oblique muscle and splitting the fibers of the external oblique. At the upper end was a fibrous strand which contained a lumen and accommodated a probe to a depth of 3 cm. A brownish liquid appeared. This was

interpreted as bile duct and several small stones were removed. There was no evidence of hernial sac. A tubulized structure entering the peritoneal cavity was interpreted as being the cystic duct; diodrast injection confirmed this belief. The tumor was found to contain a brown-stained mucus and numerous faceted gallstones. Microscopic section revealed the presence of gallbladder in the tissue. The patient made an uneventful recovery.—*Charles B. Cobern.*

#### GYNECOLOGY AND OBSTETRICS

DAVIS, EDWARD M., and POTTER, EDITH L. Intrauterine respiration of the human fetus. *J.A.M.A.*, Aug. 10, 1946, 131, 1194-1201.

The human fetus in utero under normal environmental conditions is said to be in a state of apnea. Oxygenation of the blood is carried on by the placental circulation. A great deal of previous experimental work has failed to establish the pattern of development of the respiratory mechanism in man. The relationship of intrauterine to extrauterine respiratory activity is still not understood.

The studies reported by Davis and Potter were undertaken in an attempt to obtain further evidence as to whether amniotic fluid normally moves in and out of the alveoli of the human fetus. The amniotic cavity may be entered in about 2 of every 3 patients through the abdominal wall by means of long needles of appropriate caliber. These experiments were carried out on two groups of patients: the first was made up of women in the first half of gestation, the second of women at or near term. The first series included 16 women in whom therapeutic termination of pregnancy was decided on because of some serious maternal complication.

From 12 to 40 cc. of amniotic fluid was withdrawn and replaced with thorotrast. In 12 of these 16 patients pregnancy was terminated seventeen to fifty-two hours later. In 4 patients delivery of the fetus was accomplished within thirty to sixty minutes following the injection. At the time of operation the uterus was incised and the fetus lifted out from the amniotic sac as rapidly and with as little manipulation as possible. The cord was severed and tied and the fetus sent to the roentgen laboratory immediately. All were alive and normal at birth and made active muscular movements. Their hearts continued to beat from one-half to one hour

after delivery, and all made repeated respiratory efforts. No thorotrast was demonstrated in any of the group of 4 fetuses except in the main bronchi of fetus 16, which weighed 110 gm. Microscopic examinations failed to reveal the presence of thorotrast in the lungs of the 4 fetuses.

The lungs of the previable fetuses were carefully fixed in solution of formaldehyde immediately after the roentgen examinations were completed. In the lungs of all the fetuses in which the presence of thorium could be identified by roentgen shadows, thorium could be seen histologically in the bronchi, in the alveolar ducts and in the alveolar spaces where these have become differentiated. Thorium was found in equal amounts in all parts of the group of lungs of the 12 fetuses. This would indicate that the amniotic fluid containing the thorotrast circulated freely throughout the entire pulmonary tree.

The second series of patients included 10 women at or near term who were delivered by cesarean section. From 24 to 48 cc. of amniotic fluid was withdrawn and replaced by a similar amount of thorotrast. The infants were delivered sixteen to forty-eight hours later. Roentgen examinations of the infant lungs immediately after delivery showed evidence of thorotrast in the alveolar spaces in 5, the probable presence of thorotrast in the alveolar spaces of 2 and no definite evidence in 3. It is probable that some thorium is present in the lungs of all these infants, but the concentration may not have been sufficient to produce a visible shadow. The volume of amniotic fluid varies considerably at or near term, averaging about 600 cc. The average amount of thorotrast injected, 35 cc., will yield about a 5 per cent solution. It was not considered desirable to inject more than this amount because of the radioactivity of the substance. Several of the babies were checked for radioactivity ten days after delivery and none was present.

The roentgenograms of the fetuses seem to demonstrate conclusively that amniotic fluid and its contents are normally aspirated into the lungs as part of the intrauterine respiratory activity. This phenomenon was present in the youngest fetus, weighing 39 gm. and of approximately twelve weeks gestation and continued throughout the intrauterine existence of the fetus.

This study provided pertinent information concerning gastrointestinal activity. The com-

plete gastrointestinal tract was clearly visualized in the youngest fetus, about twelve weeks old. This is the earliest demonstration of fetal swallowing and gastrointestinal function.—*Samuel G. Henderson.*

SOLEY, P. J. Uretero-pelvic obstructions in children. *J. Urol.*, Jan, 1946, 55, 46-51.

A study of 10,000 routine autopsies at Bellevue Hospital revealed 72 cases of ureteral stricture in children. According to published cases approximately one-third of these lesions are at the ureteropelvic junction. Aberrant vessels are responsible for the obstruction in a large percentage of cases.

The authors report a series of 19 cases of ureteral obstruction in children in which aberrant vessels were the causative factor in 7 and stenosis in 4.

The symptoms of ureteropelvic obstruction in children are back pain, frequency and burning on urination, vague gastrointestinal disturbances and occasionally hematuria. The authors depend mainly on the retrograde pyelogram for the diagnosis, especially when it reveals delayed emptying at ten minutes in the semi-erect position. Treatment is either by dilatation or operation.—*Rolfe M. Harvey.*

RANDALL, CLYDE L. Recognition and management of the woman predisposed to uterine adenocarcinoma. *J.A.M.A.*, Jan. 6, 1945, 127, 20-25.

Evidence is accumulating to suggest that periodic physical examinations often enable the physician to find malignant disease at an early curable stage. However, cancer developing at a hidden, inaccessible site offers little opportunity for an early diagnosis. If we could safely omit such procedures as uterine curettage for patients showing none of the factors predisposing them to the development of a type of malignancy suspected, a desirable saving of patients' funds and professional facilities would be effected. Recognition of certain lesions as pre-cancerous or recognition of the fact that a person shows a predisposition to a certain type of malignancy and employment of measures adequate to establish a diagnosis should yield results that would appear worth while to patients and physicians alike.

*Factors Predisposing to Uterine Carcinoma.*

*Age at menopause.* The evidence at hand indicates that adenocarcinoma of the uterus de-

velops more frequently among women whose periods continue past their fiftieth year.

*Body type.* Corscaden noted in 1937 that adenocarcinoma of the uterus occurred more frequently among women with wide hips and short fingers, and Scheffey was impressed by the frequency of carcinoma of the fundus among the diabetic.

*Per-existing uterine pathologic conditions.* At the present time it would appear to be the consensus that adenocarcinoma develops as frequently in fibroid as in nonfibroid uteri but that the presence of myomas in the uterus does not predispose the individual to the development of fundal carcinoma.

*Persisting estrogen stimulation.* No histologic evidence of perverted ovarian or uterine physiology has been recognized as preceding the development of adenocarcinoma constantly enough to warrant acceptance of a single endometrial state as a premalignant lesion. On the other hand, Novak has frequently referred to the possibility that hyperplasia during the climacteric or after the menopause might be a hyperplastic process preceding malignant changes in the endometrium.

*Estrogenic therapy of the menopause.* One hesitates to discuss evidence suggesting that persisting estrogen stimulation may predispose women to carcinoma of the fundus. A more practical and timely objection to the widespread use of estrogenic therapy is the fact that all too frequently the long continued use of estrogens results in uterine bleeding indicating curettage to eliminate the possibility of cancer in the fundus. If the physician assumes that the bleeding is due to the estrogens employed, he may thereby possibly neglect institution of measures adequate to diagnose an early curable carcinoma (i.e. curettage).

*Irregular or increased bleeding.* In every study of cervical or fundal carcinoma, irregular bleeding is reported to have been the earliest symptom in 95 per cent of patients. One should learn whether the bleeding is occurring during the climacteric or recurring after the menopause.

*Preclimacteric bleeding.* The frequency of increased or irregularly frequent bleeding during the so-called change of life has been calculated to be 13 women among each hundred. While menorrhagia was due to cancer in only 2.3 per cent of cases in the author's series before the menopause, when fibroids, polyps and erosion were excluded and women with a

grossly normal uterus were curetted in order to establish a diagnosis the incidence of adenocarcinoma was 9.1 per cent.

*Postmenopausal bleeding.* It is now common practice to accept no other diagnosis as the cause of bleeding after the menopause until curettage has eliminated the possibility of adenocarcinoma in the fundus. Among 186 women experiencing a recurrence of uterine bleeding one or more years after cessation of their periods, the incidence of menorrhagia during the climacteric was 33.9 per cent. This figure suggests that the woman who apparently spontaneously recovers after menorrhagia at the menopause has two and one-half times greater chance of developing postmenopausal bleeding than the woman who experienced only a normally gradual or abrupt cessation of her periods. Postmenopausal bleeding may be due to senile vaginitis, vaginal erosion secondary to prolapse, easily removed polyps or the excessive use of estrogenic therapy for menopausal symptoms. The findings in this group of cases suggest that when postmenopausal bleeding occurs the woman who experienced increased bleeding during her climacteric presents three and one-half times greater chance of having developed an adenocarcinoma of the uterus than does the woman who noted no menorrhagia during her change of life.

*The Significance of Abnormal Bleeding.* The mere fact that bleeding occurred or is occurring serves only to direct attention to a group of women among whom one should anticipate a high incidence of adenocarcinoma of the uterus. The fact that the abnormal bleeding occurred suggests the existence of a common factor among the predisposed group. There seems to be ample evidence that some degree of ovarian function precedes the development of adenocarcinoma of the uterus. Herrell has emphasized that he has never found adenocarcinoma of the uterus in a castrated woman. Adenocarcinoma has been repeatedly reported to be present in the uterus of postmenopausal women, who in addition to bleeding show breast, vulvar and vaginal evidence of the sexual rejuvenation attributed to the tumor's hormone output. The author believes that all women who develop carcinoma of the fundus after the menopause will be found among those whose symptoms and tissues suggest continued ovarian activity. Not infrequently one sees a patient experiencing hot flushes who at the same time is complaining of vaginal bleeding after the menopause. Such

patients are invariably found bleeding from a cervical or endometrial polyp or from an eroded cervix or vaginal membrane, or they have hypertension with an atrophic vaginitis and an atrophic endometrium. The woman noting postmenopausal bleeding who is not experiencing hot flushes and whose vulvar and vaginal membranes show none of the atrophic changes usually attributed to estrogen deprivation is likely to be bleeding from an adenocarcinoma of the endometrium.

In the present state of our knowledge regarding the etiology of carcinoma, few specific recommendations can be made as far as prophylactic procedures are concerned. Randall urges diagnostic curettage at the first irregularity of bleeding when women continue to menstruate after fifty years of age. When pelvic laparotomy is indicated for a woman past the child bearing age hysterectomy and probably bilateral oophorectomy will prevent the subsequent development of adenocarcinoma in the fundus. Although its effectiveness has not been convincingly shown, the author also believes that castration by irradiation is advisable whenever menstrual irregularities indicate a diagnostic curettage during the climacteric years.—*S. G. Henderson.*

BROOKE, WALLACE S., and THOMASON, J. R. Leiomyosarcoma of the uterus with metastasis to the femur. *Arch. Surg.*, Sept., 1945, 51, 120-124.

The authors review the literature and report a single case. The review of the literature would indicate that leiomyosarcoma of the uterus is a relatively uncommon lesion. It may be encountered in children but it is more common in women of the older age group, particularly in the post-menopausal period. There is no general agreement regarding the origin of the tumor. Some writers feel that these lesions are malignant from the beginning; others feel that they may represent malignant changes in a benign fibromyoma.

The authors were able to find only 3 cases in which there were bone metastasis from this lesion. They report a fourth proved case of a white woman, aged forty-three, who had a subtotal hysterectomy for menorrhagia. The clinical diagnosis before operation was myoma of the uterus. The pathological report indicated multiple fibromyomas of the uterus with malignant degeneration of a submucous fibroma. The malignancy was of the spindle cell type.



Four years after operation she began to have pain in the left hip and knee. A roentgen examination showed an osteolytic process involving the proximal end of the shaft and the head and neck of the femur. A biopsy of the lesion involving the femur showed spindle-shaped cells resembling smooth muscle cells and very little intercellular substance. The patient died approximately five years following her first operation. On autopsy, the cervical stump was involved by the tumor and there was a mass of tumor tissue which extended into the pelvis, extending through the obturator foramen and involving the proximal end of the left femur. This tumor mass also extended up along the spine to the upper lumbar region.

The diagnosis at necropsy was leiomyosarcoma with extension to the pelvis, abdomen, and left femur.—*George W. Chamberlin.*

#### GENITOURINARY SYSTEM

GOLDSTEIN, ALBERT E., RUBIN, SEYMOUR W., and ASKIN, JOHN A. Carcinoma of adrenal cortex with adrenogenital syndrome in children. *Am. J. Dis. Child.*, Nov., 1946, 72, 563-603.

A case of adrenal carcinoma with classical adrenogenital syndrome is reported in this paper which is the eighth case to be put on record in the world literature in which there was a successful operation on a child for adrenal carcinoma. It is the only one on record in which a successful operation has been performed on so young a child (eight months of age). It is also the first case in which biopsy of the adrenal glands was utilized to substantiate a pathologic diagnosis, a procedure which led to early surgical intervention and cure. The authors therefore recommend this procedure.

The roentgenographic examination of the patient showed a large tumor mass in the right side of the abdomen, displacing the right kidney downward. In the intravenous pyelograms, a double kidney with complete reduplication was shown. The roentgenograms of the chest revealed no evidence of metastatic involvement. At operation the tumor mass was successfully removed with full recovery of the patient. Clinical findings before operation were an enlarged clitoris, a palpable abdominal mass and the presence of hirsutism. After operation pyelographic examination showed normal replacement of the right kidney.

In addition to the review of the literature

with details of the 54 cases which were found, the paper contains a section on classification of adrenal cortical neoplasms, a discussion of the etiology, the diagnosis, pathology and metastasis and treatment of the condition.

In their conclusion, the authors state that those patients who manifest abnormal androgenic activity have a great chance of survival. Those patients who manifest abnormal metabolic hormonal activity have a lesser chance of survival, and their course usually terminates with a manifestation of adrenal insufficiency.—*R. S. Bromer.*

ODDO, V. J. Report of a case of acute hemorrhagic adrenalitis. *J. Urol.*, Jan., 1946, 55, 1-3.

This is a case report of a thirty-six year old white female whose chief complaint was of left upper quadrant pain, knife-like in character and of approximately one week's duration. The pain radiated to the left scapula and caudad to the bladder area. Physical examination showed deep tenderness over the left loin. An intravenous pyelogram revealed an enlarged left kidney with caudad displacement, and a soft tissue mass in the left upper quadrant displacing the stomach to the right. The temperature was septic in type. A study of the blood revealed a moderate anemia.

An exploratory operation disclosed what was apparently a large left retroperitoneal mass involving the left kidney. Removal was not considered advisable. The patient, was later discharged at her own request but after a continuously retrogressive course returned and was reoperated upon. A large hematoma was incised in the suprarenal area which was proved histologically to arise in the adrenal gland. Following evacuation of the hematoma a secondary infection of the tumor sac resulted in its obliteration and spontaneous cure of the patient resulted.—*Rolfe M. Harvey.*

#### ROENTGEN AND RADIUM THERAPY

MEIGS, JOE VINCENT. Cancer of the cervix. Editorial. *Surg., Gynec. & Obst.*, Feb., 1947, 84, 249-250.

The two papers by Graham describing the radiation reaction of cells seen in the vaginal secretion in cases of cervical carcinoma represent a potential advance in the treatment of patients with this disease. The first paper con-



cerns the distinguishing characteristics of cells exposed to radiation and their differentiation from unirradiated cells both normal and malignant. The second paper indicates a possible method of prognosis in cervical cancers under treatment by radiation. While the patient is still receiving radiation treatment, by examination of the vaginal secretion with special attention to the presence or absence of radiation reaction in the normal cells, a prognosis on the ultimate success of the treatment may apparently be obtained. It may be of basic importance that changes in the normal cells rather than disappearance of the malignant cells is the significant factor in prognosis.

Patients in whom malignant cells were found to persist in the smear for some time nevertheless did well if the normal cells showed an adequate response to irradiation; on the other hand, those patients in whom the normal cells showed no response to irradiation did poorly, even though the malignant cells disappeared.—*Mary Frances Vastine.*

SMITH, FRANK R., AND POLLACK, ROBERT S. Carcinoma of the vulva; results of treatment and effect of special factors on results. *Surg., Gynec. & Obst.*, Jan., 1947, 84, 78-84.

Two hundred and twenty-eight cases of cancer of the vulva were studied. The condition is most prevalent during the seventh decade; over half the patients experienced pruritus, and more than 80 per cent of the lesions were of the epidermoid variety. The melanomas showed the lowest survival rate.

One hundred cases form the basis for the report of five year cure rates. Best results were obtained when a vulvectomy and bilateral groin dissection, without removal of the iliac nodes, was performed. When the disease extends to the inguinal lymph nodes, the prognosis is markedly altered. The overall absolute five year cure rate was 26.00 per cent.—*Mary Frances Vastine.*

CAMPBELL, RALPH E. The treatment of pelvic tuberculosis in the female by radiation therapy based upon experimental evidence in the animal and clinical results in the human.

*Am. J. Obst. & Gynec.*, March, 1947, 53, 405-418.

Roentgen therapy, by producing a temporary or permanent castration, tends to conserve the patient's blood and undoubtedly adds to her resistance. This is particularly important in the anemic patient.

Jameson has pointed out that it is a well recognized clinical observation that tuberculous women are unfavorably affected by their menses. The cough becomes more severe and distressing, the expectoration may be increased, and dyspnea more marked. Examination of the lungs at this time usually shows increased physical signs and sudden changes in the progress of the disease are likely to occur.

By analogy it seems logical that due to the increased activity and vascular changes in the pelvis at the time of the menses, a deleterious effect would be produced upon the pelvic tuberculosis as is produced in the lung. In fact, temporary or permanent castration by roentgen rays in the pelvic tuberculosis may be a blessing in disguise.

The roentgen-ray dosage as carried out in this series is not large enough to have a profound effect upon the white blood cells and the author cannot agree that it interferes with healing. On the contrary, it is a well known fact that roentgen rays do stimulate the production of young fibroblasts which is most important in the conversion of tubercles into fibrous tissue.

Roentgen rays are useful in reducing secondary inflammation and infection which is important in the healing of a tuberculous process.

There is no real evidence as substantiated by these studies that fistulas, dissemination of the tuberculous process, intestinal obstruction, and perforation of a viscus are serious complications of roentgen therapy. In fact, the author has cured one fistula of tuberculous origin by deep therapy. It may also be said that deep therapy is useful in the absorption of exudate and the reduction of secondary inflammation and infection, thereby tending to relieve and prevent intestinal obstruction.—*Mary Frances Vastine.*

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## THE DIFFERENTIATION OF PATENT DUCTUS ARTERIOSUS AND ATRIAL SEPTAL DEFECT\*

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IT IS probable that the experience of this audience in the identification of congenital cardiovascular lesions has been much the same as ours. Since the advent of surgical measures designed to correct, or to partially compensate for some of these defects, more patients have been available for study, and the differentiation of the various lesions has become of immediate importance. The syndromes resulting from a congenital cardiovascular lesion may be so typical that a substantially correct diagnosis can be made in a large percentage of cases. Patent ductus arteriosus and atrial septal defect can be differentiated by their clinical and roentgenological features.

An abstract of Maude Abbott's analysis of 1,000 postmortem cases<sup>1</sup> reveals that, as a primary lesion, patent ductus arteriosus occurred 92 times and atrial septal defect, 73 times. The defects co-existed in 16 of these 165 cases. Statistical reviews on patients attending cardiac clinics<sup>10</sup> have established the high incidence of congenital lesions and have emphasized the frequency of atrial septal defect as a pure lesion.<sup>2</sup>

Numerous reviews of the clinical and post-mortem findings in patients with patent

ductus arteriosus and atrial septal defect are available in the English medical literature.<sup>2,5,8,11,12,14,15</sup> The differentiation of these two lesions will be approached by reviewing their effects on the circulation by diagrammatic means (Fig. 1). These diagrams are modifications of many somewhat similar schemes which serve to provide a basic framework for the correlation of clinical findings. In patent ductus arteriosus (Fig. 1A), blood from the aorta, the highest mean pressure point of the circulatory system, is shunted to the pulmonary artery, already filled with blood. The pulmonary artery dilates to accommodate this increased volume which, on returning to the heart, causes enlargement of the left atrium. The increased filling of the left atrium, and of the left ventricle, increases the systolic output delivered to the aorta. Even though a considerable part of the left ventricular output is shunted through the ductus,<sup>6</sup> the peripheral flow is usually only slightly decreased. The shunt occurs between high pressure vessels, but we believe the pressure differential is sufficiently high to cause blood to flow through the ductus only from the aorta to the pul-

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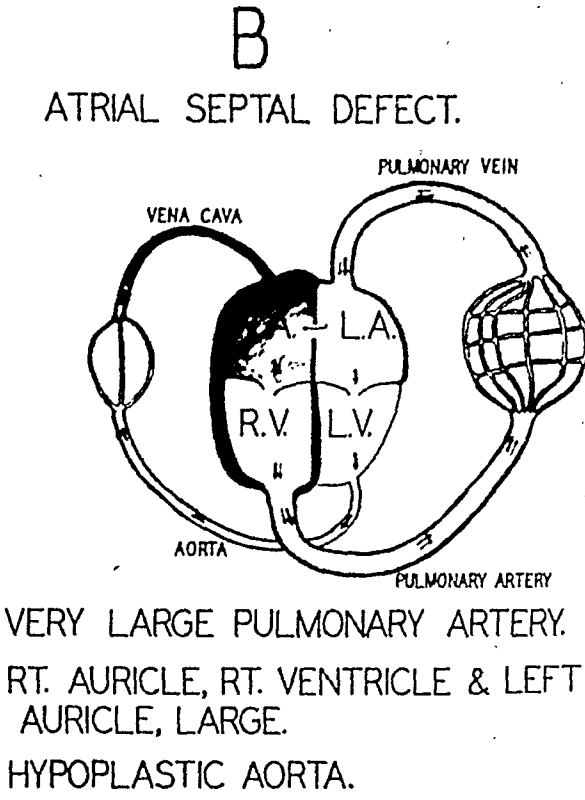
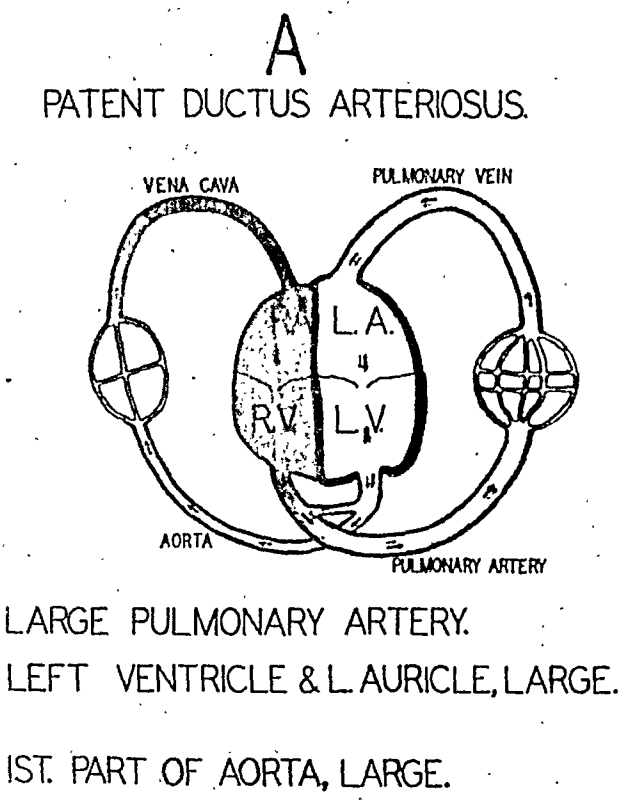


FIG. 1. Schematic diagram illustrating modification of the heart and circulation in (A) patent ductus arteriosus and (B) atrial septal defect.

monary artery. We have never seen cyanosis which could be attributed definitely to a reflux of venous blood through an uncomplicated patent ductus.

In atrial septal defect (Fig. 1B), the right atrium receives the peripheral venous flow and apparently, in numerous instances, a large complement of blood from the left atrium. This increased volume of blood causes great enlargement of the right atrium and right ventricle; it increases right ventricular systolic output<sup>3</sup> which results in considerable enlargement of the entire pulmonary vascular system. When this increased blood volume is returned to the left side of the heart, the interatrial septal defect provides an escape mechanism which prevents an otherwise extreme enlargement of the left atrium, but the run-off through the septal defect also decreases left ventricular filling. This decreased filling results in decreased left ventricular output and decreased peripheral blood flow. Although the arrow between the left and

right atria points only in one direction, it is probable that slight pressure changes will cause a reversal of flow; venous blood will enter the left side of the heart and be delivered to the peripheral circulation. Careful observation or an adequate history will occasionally elicit evidence of transient slight cyanosis in infants with an interatrial septal defect.

We are not aware of proof for all of these hypotheses but their probabilities will be supported by illustrations from some of our patients who have shown the characteristic signs of patent ductus arteriosus and of atrial septal defect. Usually, a sufficient combination of these findings to establish a clinical diagnosis will be present. Pure patent ductus arteriosus or atrial septal defect can be recognized as successfully as acquired valvular heart disease.

Figure 2 is from an opacification study obtained on a girl, aged thirteen, who had patent ductus arteriosus. After diodrast injection, the right ventricle and pulmon-

FIG. 2. Posteroanterior chest roentgenogram taken four seconds after injection of 50 cc. of 70 per cent diodrast into the left cubital vein. There is opacification of the right heart and pulmonary vessels.

ary arteries are clearly shown. The main pulmonary stem, as well as its various branches, is large and the interventricular septum lies well within the cardiac silhouette. Thus, the increased total transverse diameter is due to the relatively large size of the left ventricle; the base of the right ventricular shadow is approximately normal. We believe the aortic shadow, uninjected and well delineated from the pulmonary artery, is large for a thirteen year old female, weighing 116 pounds. Left ventricular enlargement, dilatation of the pulmonary artery and a normal or large aorta, are findings associated with patency of the ductus arteriosus. Figure 3<sup>7</sup> shows the blood pressure determinations of this

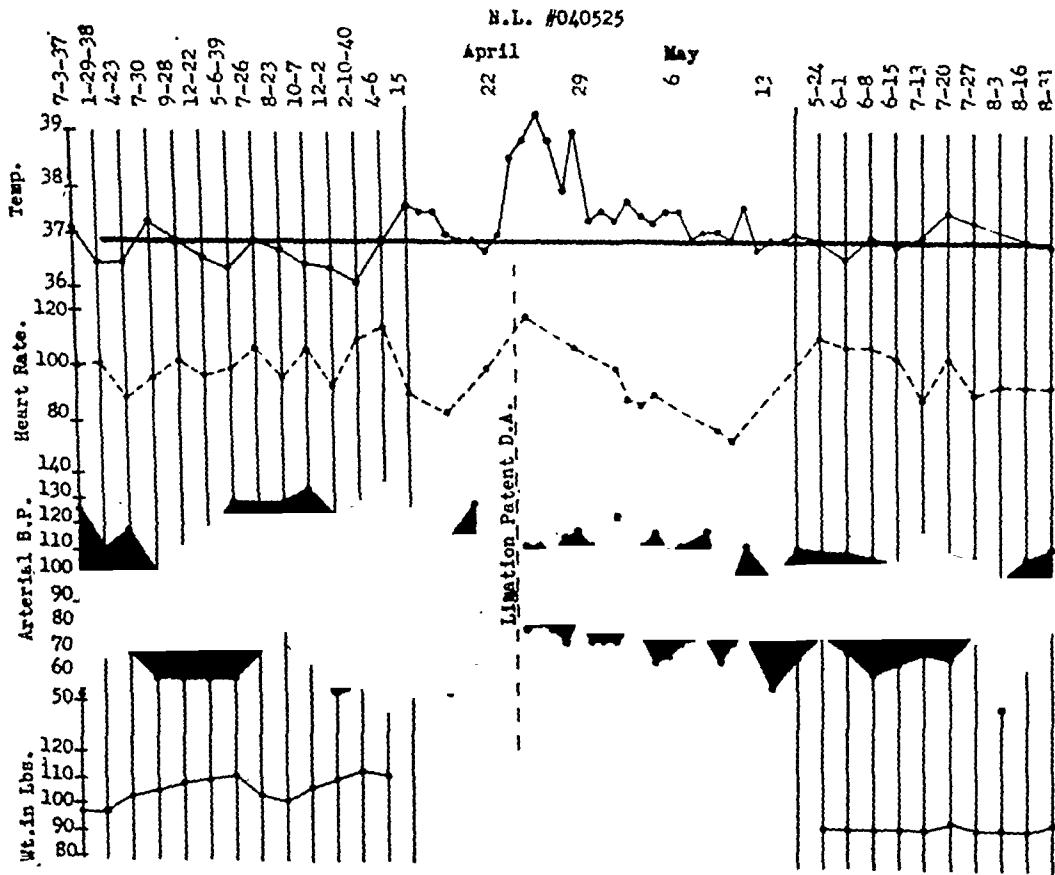


FIG. 3. Blood pressure determinations before and after ligation of a patent ductus arteriosus.

same patient. Ligation of the patent ductus was done on April 23, 1940, and there was an immediate fall in the systolic pressure and a rise in the diastolic pressure. The normal blood pressure and smaller pulse pressure obtained postoperatively are clearly demonstrated. The increased pulse pressure, resulting from patency of the ductus arteriosus, is usually not so marked as exists in an acquired left-sided arteriovenous shunt of similar size or in marked insufficiency of aortic valvular heart disease.

there is a semicircular line of calcification (arrow) in the aortic arch, superimposed upon the lower part of the aortic knob. As verified at postmortem, this shadow outlines the aortic opening of a patent ductus arteriosus. Such a finding, described by Weiss<sup>16</sup> is rare, but it may be helpful in establishing a diagnosis.<sup>4</sup> The entire aorta can be clearly seen in the lateral projection (*B*). Such an aorta is abnormally large for a frail female weighing 97 pounds. Even though the enlargement cannot be demon-

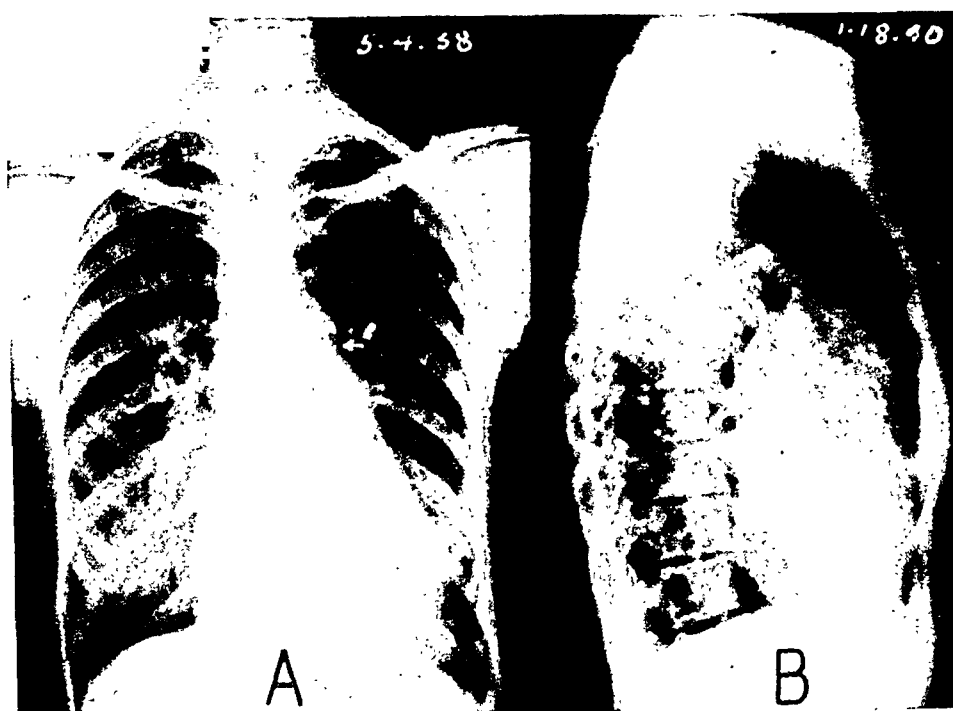


FIG. 4. Posteroanterior and lateral views of the chest showing calcification (retouched) at the aortic orifice of a patent ductus arteriosus.

However, this increased peripheral pulse pressure is a definite help in establishing a diagnosis of patent ductus arteriosus and particularly helpful in differentiating patent ductus arteriosus from an atrial septal defect. The electrocardiogram (Fig. 2) was essentially normal. We believe the diphasic QRS complex in Lead I represents a persistence of the infantile pattern.

Figure 4 represents roentgenograms of the chest of a female, aged thirty-seven. The relatively large aorta, the slight prominence of the pulmonary artery and the large ventricular shadow are shown in the posteroanterior projection (*A*). In addition,

strated roentgenologically, we believe the first and second portions of the aorta are always enlarged in an uncomplicated patent ductus arteriosus and the entire aorta may be abnormally prominent. The axis of the electrocardiogram was normal.

Figure 5 represents two posteroanterior views of the chest of a well developed female, now forty-three years old. Her heart is slightly enlarged now (*A*), as it was when she was first seen in 1940 (*B*). The aortic knob is prominent and the ventricular mass extends posteriorly to an abnormal extent in the left oblique view (Fig. 6*B*). The pulmonary artery is slightly enlarged.

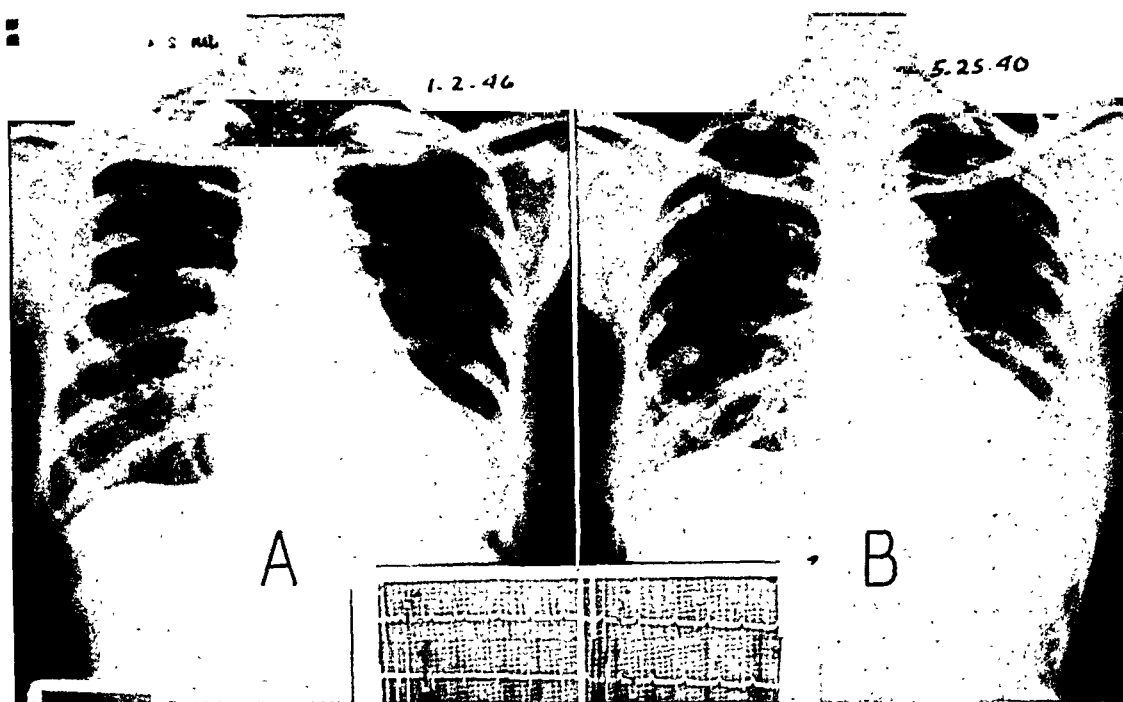


FIG. 5. Posteroanterior views of the chest of a patient with patent ductus arteriosus. There is a six year interval between these films.

This enlargement is more marked in Figure 5A than in Figure 5B, six years earlier. The right oblique projection (Fig. 6A) is of more assistance, as it shows a moderate prominence of the upper cardiac shadow, indicating definite enlargement of the pulmonary artery. The electrocardiogram

shows a left axis deviation (Fig. 5). A continuous loud systolic and a loud blowing diastolic murmur has always been present, most often with a systolic accentuation. In addition, a very definite systolic thrill is palpable in the third left interspace corresponding to the site of the maximum

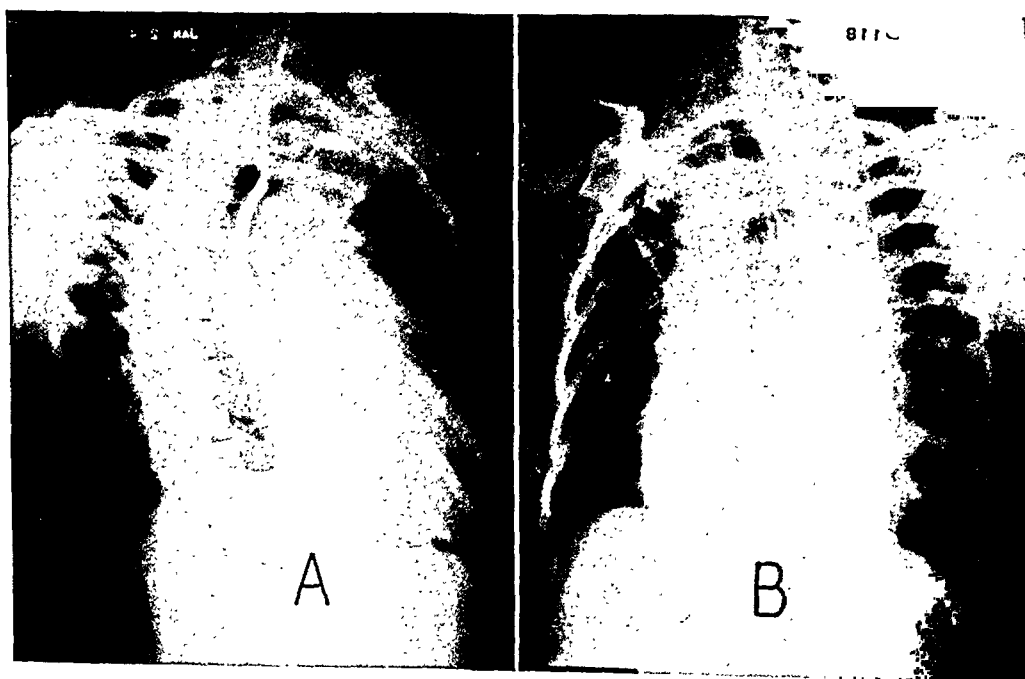


FIG. 6. Right (A) and left anterior oblique (B) views, same patient as Figure 5.

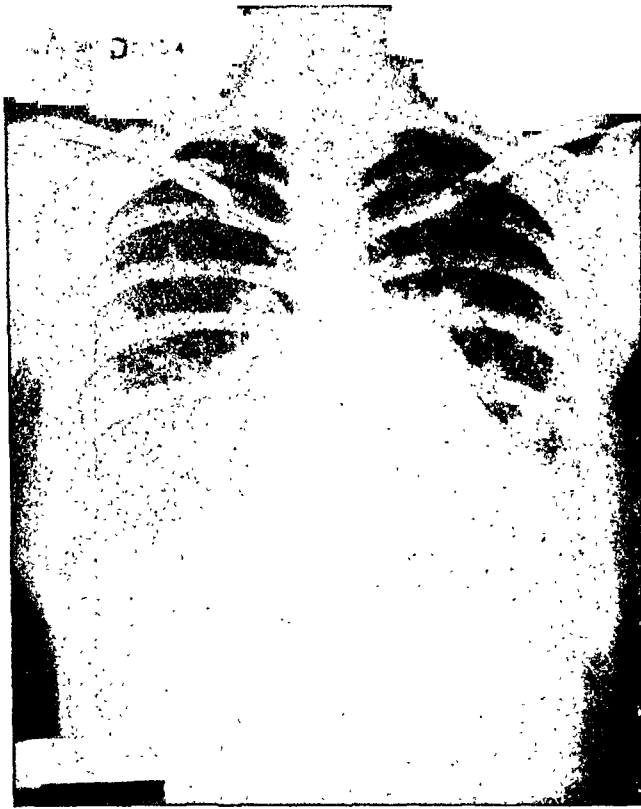


FIG. 7. Chest roentgenogram of patient with atrial septal defect.

intensity of the murmur. The patient's blood pressure is variable but an average reading is 136/80. We are reasonably sure

that this patient has a patent ductus arteriorus.

Figure 7 is a posteroanterior projection of a heart with a typical atrial septal defect. The patient is a widow, aged forty-six, who was closely supervised for twenty years because of a mistaken diagnosis of rheumatic mitral stenosis. She had no symptoms of heart disease. After physical examination, our Medical Resident disagreed with the accepted diagnosis. Simultaneously, the X-ray Department suggested that the patient had an atrial septal defect. The great enlargement of the pulmonary artery and its branches and the marked enlargement of the heart are clearly shown. The aortic arch is small and there is no chronic passive hyperemia of the lungs (Fig. 7). Despite the great increase in the transverse diameter of the heart, the ventricular mass does not extend posteriorly to any considerable extent in the left oblique position (Fig. 8*B*). The right ventricle is enlarged. Under the roentgenoscope the large comma-shaped vessels in the right hilum were seen to pulsate. The retrocardiac space is clear and the esophagus is straight in the right oblique projec-

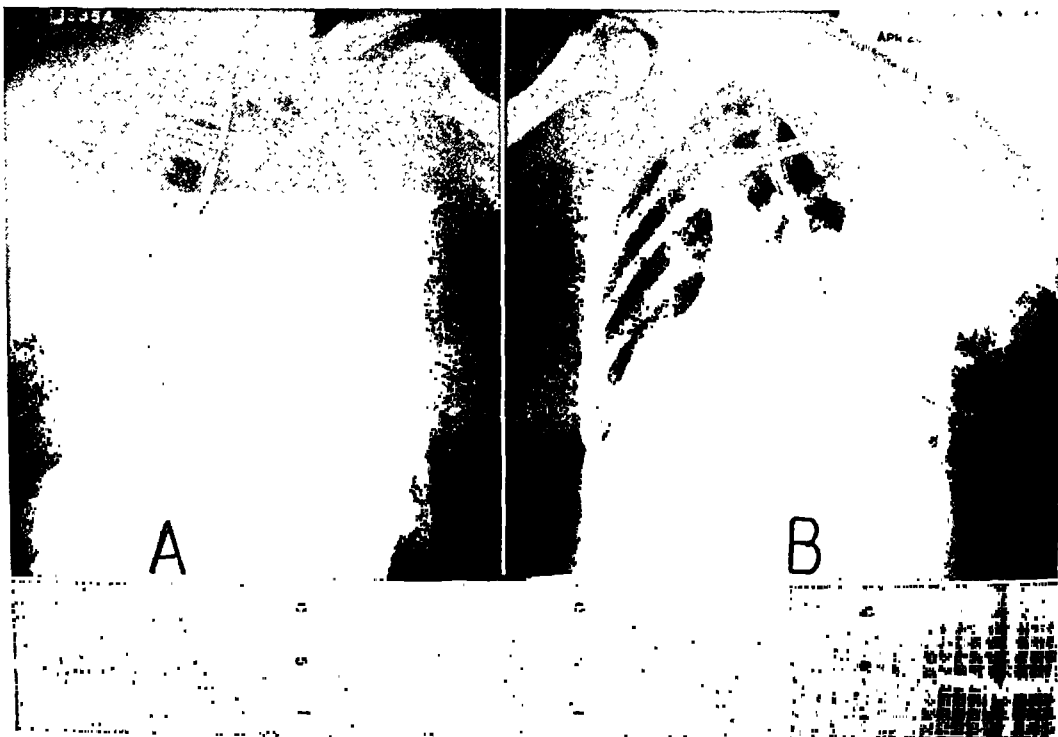


FIG. 8. Right (*A*) and left (*B*) anterior oblique views of same patient as Figure 7.

tion (Fig. 8A). The latter findings are particularly valuable in disproving a diagnosis of mitral stenosis. We have never seen, and find it impossible to imagine, a situation in which an uncomplicated mitral stenosis could cause excessive dilatation of the pulmonary artery and of the right heart without marked enlargement of the left atrium and consequent encroachment on the esophagus and retrocardiac space. Severe rheumatic heart disease and mitral stenosis should produce some clouding of the lung parenchyma; there should be moderate physical disability and moderate dyspnea on exertion. There is a right axis deviation of the electrocardiogram (Fig. 8). The diagnosis of atrial septal defect was finally accepted by all physicians interested in the patient. A right axis deviation of the electrocardiogram is never found in an adult with uncomplicated patent ductus arteriosus.

Figure 9 is the chest roentgenogram of a male patient, now thirty years of age. He is an asthenic individual, who was in fair health except for slight shortness of breath on exertion until he was twenty-two years old. He was then admitted to a tuberculosis sanatorium for observation because of a "large right hilar shadow." The diagnosis was changed to rheumatic heart disease with mitral stenosis and aortic insufficiency. The patient subsequently had two periods of congestive cardiac failure, apparently almost entirely right-sided. At present, he is working and comfortable, except for shortness of breath on more than moderate exertion. There is a definite prominence of the left anterior chest wall near the sternum at the level of the second, third and fourth ribs. Variable double murmurs, with the diastolic element most prominent, are present with a maximum intensity in the third left intercostal space. An average blood pressure determination is 100/76. With best health, his hemoglobin is 18.5 grams and the red blood cell count 5.99. The cardiac shadow (Fig. 9) has a large transverse diameter, a marked prominence of the right and main pul-

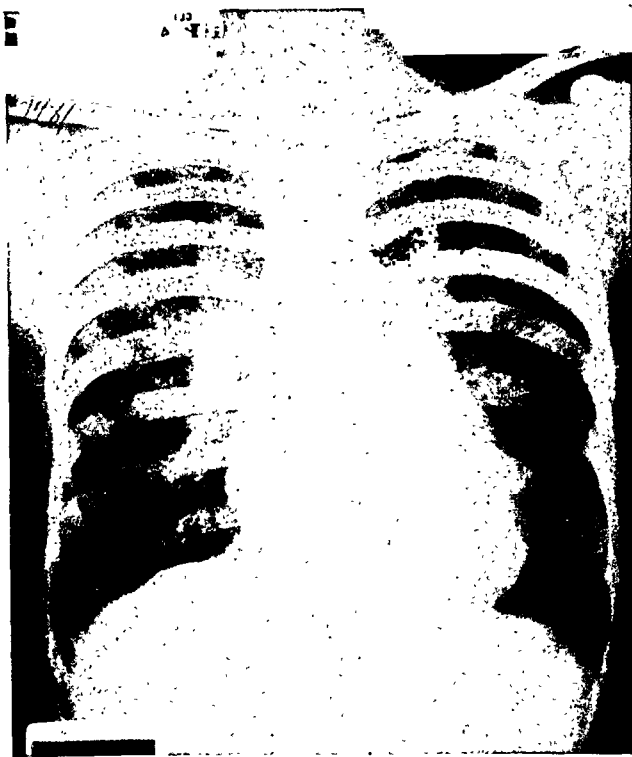


FIG. 9. Posteroanterior chest roentgenogram of patient with atrial septal defect.

monary arteries and an indefinite aortic arch. In the right oblique view (Fig. 10A), the large pulmonary artery is responsible for the increased depth of the upper cardiac shadow; the retrocardiac space remains relatively clear although there is slight indentation of the esophagus. The left oblique view (Fig. 10B) shows enlargement of the right ventricle and the large pulmonary artery and its branches obliterating the aortic window. The electrocardiogram (Fig. 10) has a right axis deviation and the P waves, particularly in Lead II, are abnormally tall and peaked. The evidence clearly indicates that the major defect in this patient is an atrial septal defect. It is possible that a mitral stenosis (Lutembacher's syndrome)<sup>9</sup> is also present.

Figure 11 shows in more detail some of the electrocardiographic abnormalities associated with an atrial septal defect. These records were obtained from a patient, now twenty-three years old, who has been under our observation for sixteen years. He was a frail child with associated congenital abnormalities of the osseous and muscular system. The cardiac mechanism has never



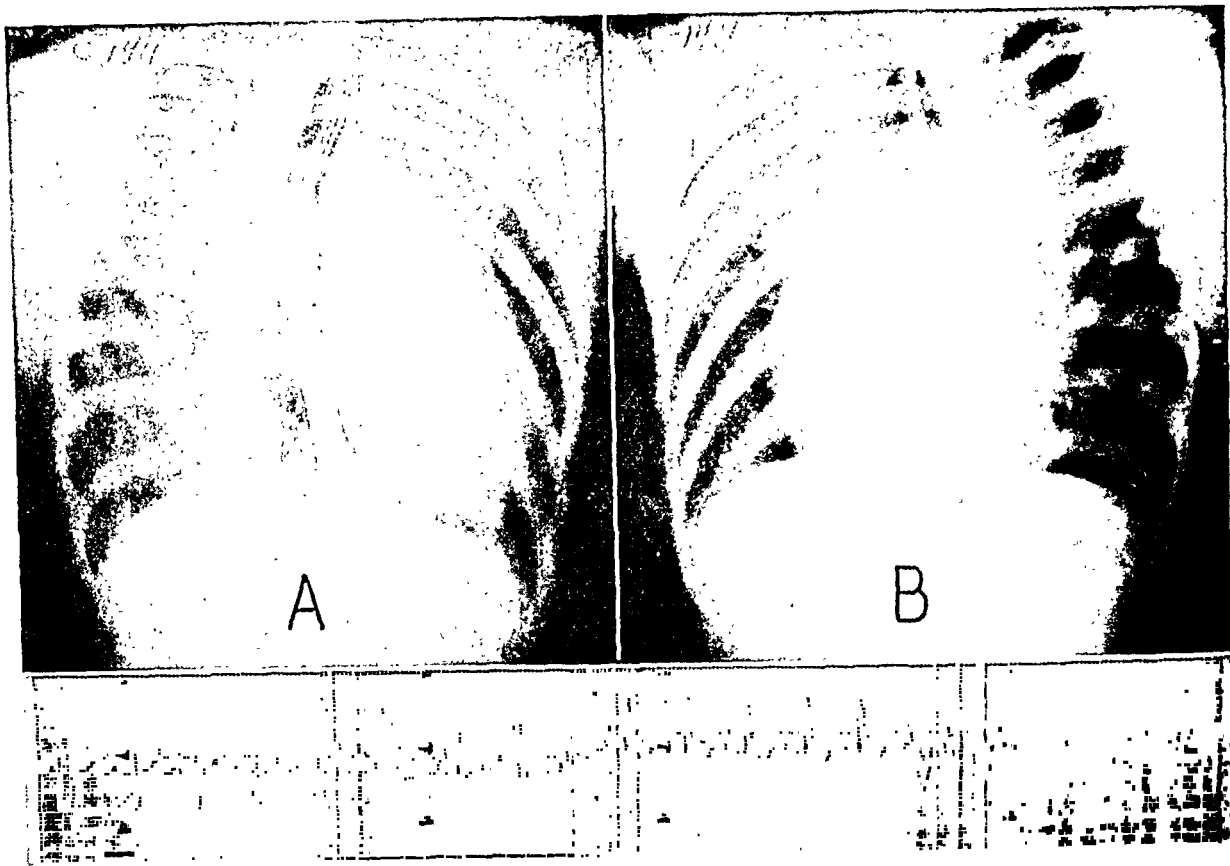


FIG. 10. Right (A) and left (B) anterior oblique views of same patient as Figure 9.

been stable, and the irregular rhythm in Figure 11A is due to a shifting pacemaker. In Figure 11B, a period of normal sinus rhythm is present, but there is a right axis deviation manifested by a deep S wave in Lead I and a tall, upright R wave in Lead III; abnormal P waves are clearly seen in Lead II.

The next case would have been handled

differently if we had been more certain of our diagnostic abilities in 1940. The patient was a female, aged forty-two months. She had a double murmur without systolic accentuation and there was a definite localized prominence of the anterior left chest wall at the level of the second and third ribs. The electrocardiogram has a right axis deviation (Fig. 12). The heart shadow

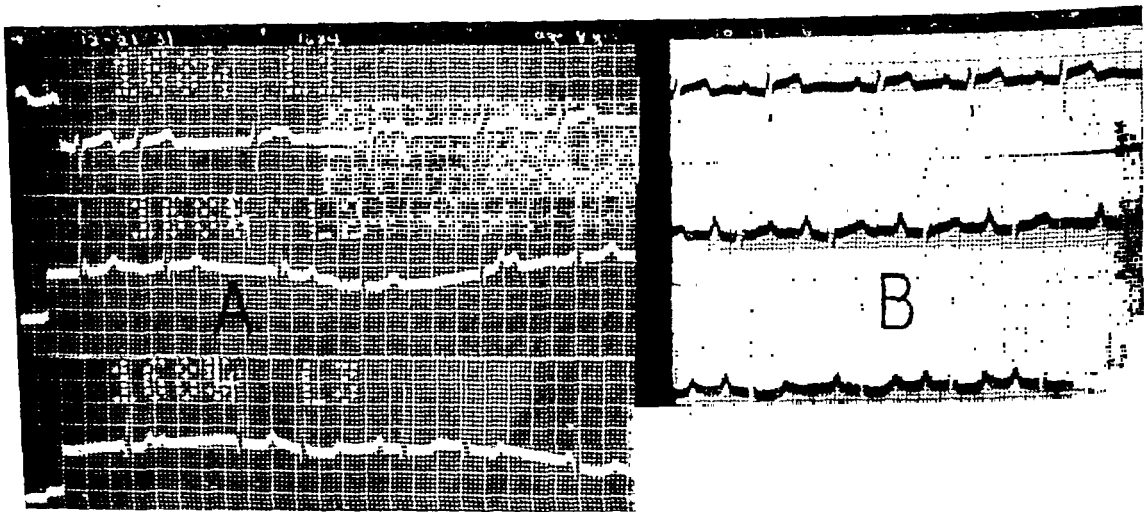


FIG. 11. Electrocardiogram showing abnormalities present with atrial septal defect.

is increased in size (Fig. 12), and the aortic arch cannot be identified. Over-exposed films (Fig. 13*A*) show the right ventricle, filled with diodrast, to represent almost the entire transverse shadow of the heart, while the prominent knob above the upper left border of the heart is clearly demonstrated to be a very large pulmonary artery. In Figure 13*B*, taken four seconds later, diodrast has filled the aorta which is smaller than the main pulmonary trunk. After considerable discussion, an exploratory operation of the chest revealed only a large, tense pulmonary artery, and no patent ductus or other abnormalities of the large vessels. The preoperative studies in retrospect clearly indicated such a probability. Now, we believe there was good clinical evidence of an atrial septal defect and operation should have been clearly contraindicated.

Table 1 represents the main factors which are important in the differentiation of these two congenital defects of the circulation. In patent ductus arteriosus, we have

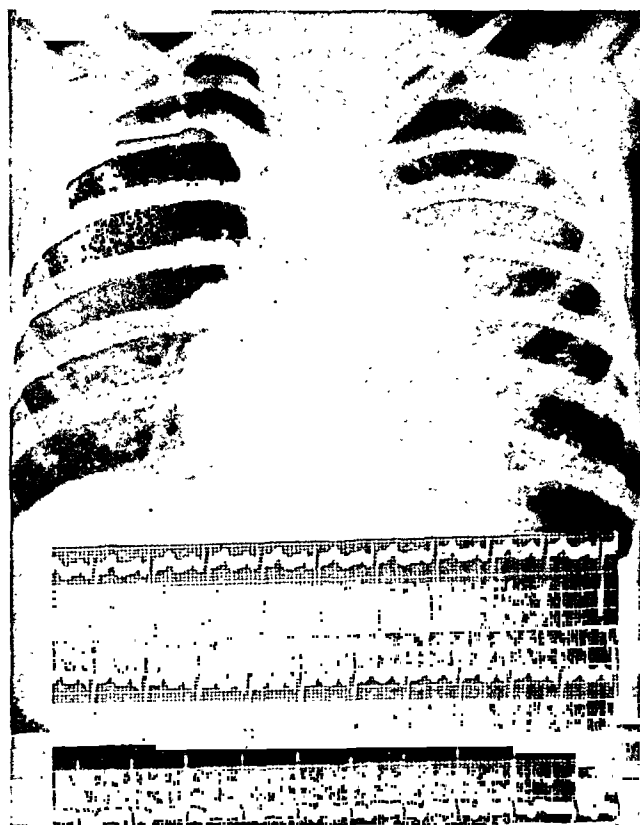


FIG. 12. Chest roentgenogram of a female, aged forty-two months, with atrial septal defect.

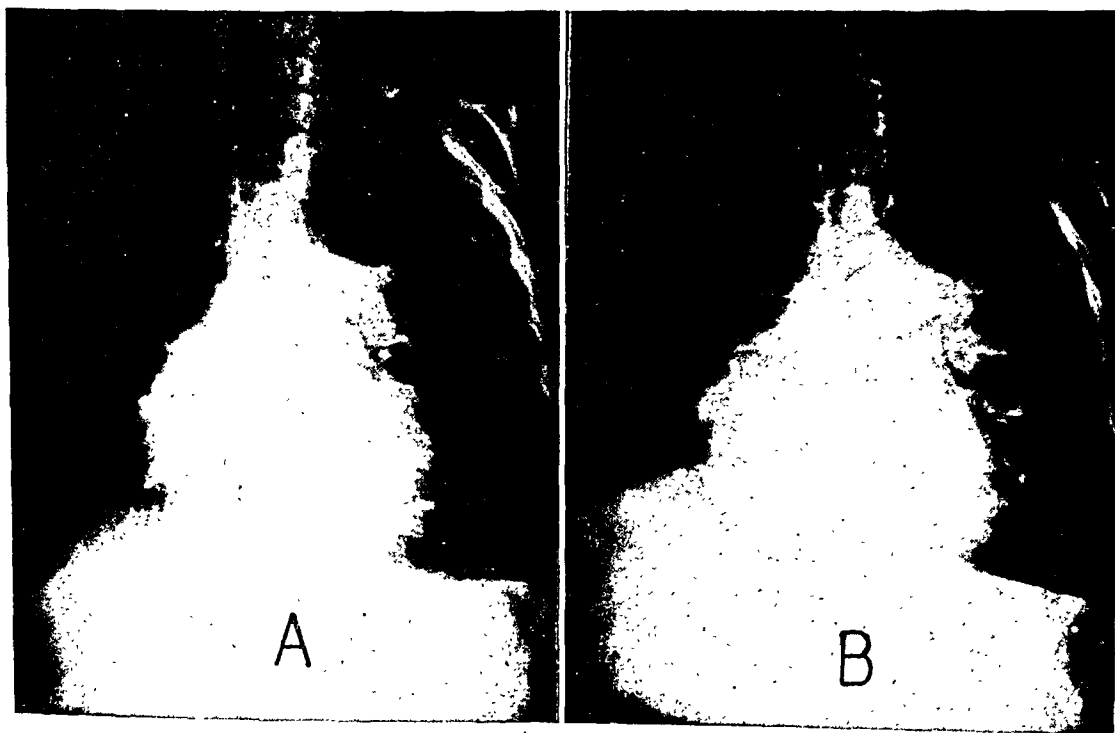


FIG. 13. Over-exposed posteroanterior chest roentgenograms made after injection of 70 per cent diodrast. The pulmonary artery is well opacified in *A* and the shadow of the aorta is accentuated in *B*.

been impressed with the absence of cyanosis, the prominent thrill and the characteristic murmurs, the essentially normal electrocardiogram with normal sinus rhythm, and on roentgen study, by the large heart with the unusual combination of occasional slight enlargement of the left artium and definite enlargement of the left ventricle, pulmonary artery and first and second portions of the aorta. We are particularly in-

struction may be a cause for retardation of development in infancy. As the child grows and the tracheal bifurcation descends, relatively more space is available for upper mediastinal structures and partial tracheal obstruction is spontaneously relieved.

Of less importance in the diagnosis of patent ductus arteriosus is a localized pulsation in the second or third left interspace due to the slight-to-moderate en-

TABLE I  
IMPORTANT FACTORS IN THE DIFFERENTIAL DIAGNOSIS OF PATENT DUCTUS  
ARTERIOSUS AND ATRIAL SEPTAL DEFECT

<i>Patent Ductus Arteriosus</i>	<i>Atrial Septal Defect</i>
1. Normal development after infancy	1. Subnormal physique
2. No cyanosis	2. Minimal transient cyanosis
3. Localized pulsation in 2nd left interspace	3. Localized prominence of left anterior chest wall in region of 2nd, 3rd and 4th interspaces
4. Maximal systolic and diastolic thrills	4. Variable thrills
5. Usually typical murmurs	5. Variable murmurs
6. High systolic, low diastolic blood pressure	6. Low systolic blood pressure and narrow pulse pressure
7. Normal electrocardiogram or left axis deviation. Normal sinus rhythm	7. Right axis deviation of electrocardiogram. Large P waves. Various arrhythmias
8. Enlargement of left ventricle and left auricle. Large pulmonary artery. Large aorta	8. Enlargement of right auricle and right ventricle. Great dilatation of pulmonary artery. Hypoplastic aorta
9. Slight circulatory insufficiency	9. Congestive cardiac failure, preponderately right-sided
10. Subacute bacterial endocarditis	10. Acquired valvular heart disease

terested in these latter findings for we believe they are responsible for some of the respiratory difficulties of infants with a patent ductus. The increased blood volume and the re-circulation through three large vessels (aorta, pulmonary artery and patent ductus arteriosus) creates an unusual mass of great vessels. The slightly large left atrium presses the tracheal bifurcation from below in a cephalad direction; a large ductus and large pulmonary arteries exert pressure posteriorly and medially to the right; the large first and second portions of the aorta have a similar tendency. As a result, tracheal deviation with compression and partial obstruction, particularly of the left main branch, occurs. In some infants, we believe such an obstruction is a factor in the frequency, persistence and severity of pulmonary infections and that the ob-

largement of the pulmonary artery. An increased pulse pressure is occasionally of value in differential diagnosis. Bacterial endocarditis, when present, is presumptive evidence against an atrial septal defect. Slight circulatory insufficiency is usually present in patent ductus arteriosus, although it may not be appreciated by the patient or physician until operative closure of the ductus has been affected.

In atrial septal defect, we have been most impressed by the variability of murmurs and thrills, by the right axis deviation and abnormal P waves of the electrocardiogram which may also show an unstable cardiac conduction mechanism. The roentgen findings are of paramount importance because of the characteristic increase in the size of the heart due to the marked increase in the size of the right atrium and ventricle.

The dilatation of the pulmonary artery and its branches or the dilatation of the conus is a constant finding. In contrast, the aortic knob is small and inconspicuous.

Patients with atrial septal defect show a definite tendency to subnormal physique, particularly in infancy, but one of our patients, who was a small child with transient slight cyanosis, has developed into a semi-professional baseball pitcher with the body build of a gladiator. The localized prominence of the left anterior chest wall may be absent; occasionally, it is of great help in differentiating this lesion from patent ductus arteriosus, for this sign tends to be conspicuous in the younger age group in whom the roentgen-ray silhouette is less characteristic. These patients have a low systolic blood pressure and narrow pulse pressure; such a finding in a patient with marked enlargement of the heart is an obvious paradox. Acquired valvular heart disease, particularly a co-existing mitral stenosis, is consistent with atrial septal defect and it is interesting that bacterial endocarditis is rare. Congestive cardiac failure tends to occur late. It is almost pure right-sided failure.

The total combination of the differentiating points in Table I is an ideal pattern, the construction of which has been an interesting study to us. It has proved to be increasingly valuable as more attention has been centered on eliciting the various factors in individual patients.

#### SUMMARY

Since the advent of surgical measures to correct or modify various types of congenital heart lesions, more interest has developed in the differential diagnosis of these conditions. Two of the most common abnormalities are patent ductus arteriosus and atrial septal defect. They present sufficiently characteristic findings to enable one to make the correct clinical diagnosis in a large percentage of cases. These findings have been illustrated by cases of patent ductus arteriosus and atrial septal defect. The important features in the differential diagnosis have been presented in tabular

form. We believe that the diagnosis can be made with the same exactitude as in acquired valvular heart disease.

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# SYNDROME OF ABERRANT RIGHT SUBCLAVIAN ARTERY WITH PATENT DUCTUS ARTERIOSUS\*

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## INTRODUCTION

**A**BERRANT right subclavian artery is the most common of all congenital anomalies of the aortic arch. In this anomaly, the right subclavian artery takes origin from the extreme left side of the aortic arch, posteriorly and to the left of the

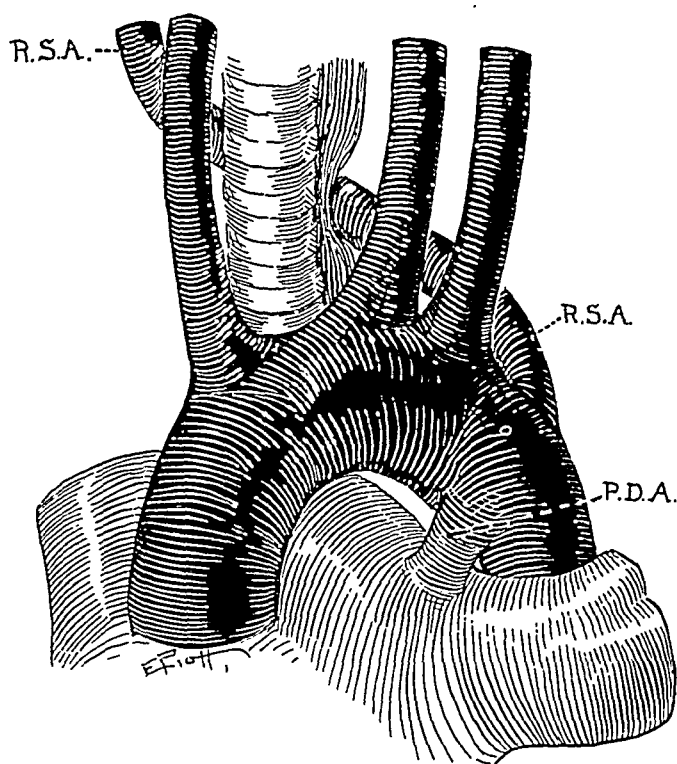


FIG. 1. Aberrant right subclavian artery with patent ductus arteriosus. Drawing of the great vessels showing the patent ductus arteriosus, *P.D.A.*, and the obliquely ascending course of the aberrant right subclavian artery, *R.S.A.*, behind the esophagus which is indented posteriorly.

origin of the left subclavian. The aberrant vessel runs obliquely upward and to the right, usually passing behind the esophagus as it crosses the midline. The embryologic background of this anomalous origin and course is known and is discussed below.

The main clinical and roentgenologic features of anomalous subclavian artery are

now well defined and several cases in which the roentgen diagnosis has been made have been reported.<sup>5,12,13</sup> However, the relatively high incidence of coexistent congenital heart disease, particularly anomalies of the cardiac base such as patent ductus arteriosus (Fig. 1) and the tetralogy of Fallot, has not been recognized. The group of cases to be reported is part of a series of 15 patients, all infants or young children, in whom the diagnosis of aberrant right subclavian artery has been made.

## ANOMALOUS SUBCLAVIAN ARTERY

The clinical aspects of anomalous right subclavian artery and of other anomalies of the aortic arch have recently been reviewed by Gross and Ware.<sup>11</sup> The roentgen diagnosis of this vascular deformity, together with its diagnostic differentiation from posterior right aortic arch and double aortic arch, has recently been reviewed by Neuhauser<sup>12</sup> and by Copleman.<sup>5</sup>

The anomaly is often asymptomatic or associated with only mild feeding difficulty. However, it occasionally results in marked dysphagia by its extrinsic pressure on the esophagus, thus constituting a true "dysphagia lusoria." A surgical procedure to relieve the dysphagia of anomalous subclavian artery has been devised by Gross and successfully carried out in 2 cases.<sup>11</sup>

The characteristic course of the aberrant vessel, from its origin far to the left on the aortic arch, passing obliquely upward and to the right behind the esophagus, produces a typical oblique extrinsic filling defect in the posterior esophageal wall. Anomalous subclavian artery passing between esophagus and trachea or anterior to the trachea is uncommon and has not been encountered in this series.

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## PATENT DUCTUS ARTERIOSUS

In every case the diagnosis must be made by adequate clinical evidence. This should include in patients beyond infancy, the characteristic systolic and diastolic "machinery murmur" in the pulmonic area, together with widened pulse pressure and some retardation of somatic growth.

Roentgenologic criteria for the diagnosis of patent ductus arteriosus are well established.<sup>7</sup> When present they include total cardiac enlargement, left ventricular hypertrophy, dilatation of the left atrium and prominence of the pulmonary artery segment of the cardiac shadow. The hilar and pulmonary vessels are usually engorged. The left ventricle and pulmonary artery segment show increased amplitude of pulsation and there may be visible expansile pulsation of the hilar vessels ("hilar dance"). Any or all of these signs may be lacking in any individual case.

## CONGENITAL HEART DISEASE WITH ANOMALOUS SUBCLAVIAN

Fifteen cases of anomalous right subclavian artery have been discovered by roentgen examination at the Children's Hospital in the year from September, 1945 through August, 1946. Five of these children had undoubted congenital heart disease as well, 2 being surgically verified. Three of the congenitally abnormal hearts were clinically and roentgenologically typical of patent ductus arteriosus, 1 being surgically verified. The fourth was a tetralogy of Fallot, surgically verified. The fifth was a congenital abnormality of indeterminate structure, but apparently involving an intracardiac shunt.

The coexistence of a patent ductus arteriosus in 3 out of 15 patients with an aberrant right subclavian artery suggests that the two entities may be related, either by one constituting direct causation for the other, or by virtue of a common etiology and pathogenesis for both. In the light of present knowledge of the effect of certain virus infections in the first trimester of pregnancy, the latter possibility is sug-

gested. German measles in early pregnancy is now known to be a common and potent cause of congenital heart disease, cataract, deafness and other anomalies.<sup>6,8,9,10</sup> In 1 of the 3 cases (Case II), a common etiology is evident; in another (Case III), a common etiology is suspected. Evidence bearing on this problem is presented in the case reports and is discussed below.

## CASE REPORTS

Case I (Record No. 304,068). B. W., female, aged three years, seven months, entered the Medical Outpatient Department on April 11, 1946, for investigation of a previously discovered heart murmur. Her father, an electrician, aged twenty-seven, and her mother, aged twenty-three, were living and well; there were no familial diseases. No siblings. Mother denied any illness during pregnancy. Birth was full term with a normal delivery. Birth weight  $7\frac{1}{2}$  lb. There was no neonatal cyanosis, and development of motor activity was normal. Throughout infancy she suffered from marked difficulty in swallowing both liquid and solid food, with ready and frequent regurgitation. This decreased as she grew older, but she is still described by her parents as a slow eater. She had never had dyspnea, orthopnea, cyanosis, weak spells or edema.

Physical examination showed a thin female child, weight  $27\frac{3}{4}$  lb. (average normal for age 33 lb.), temperature  $99.8^{\circ}$  F.; pulse 108. No cyanosis. Skin, head, eyes, ears, nose and throat negative. Chest shape was not abnormal and heart was not enlarged to physical examination. There was a thrill in the second and third interspaces just to the left of the sternum, with a loud blowing systolic and diastolic "machinery murmur" at this site. Rhythm regular. Blood pressure 100/60. Lungs were clear to percussion and auscultation. Abdomen, genitalia and extremities negative. No clubbing of fingers or toes.

Electrocardiogram was normal; no axis deviation present.

Roentgenographic and roentgenoscopic examination (X-ray No. A481) showed the heart at or just beyond the upper limit of normal in size with enlargement of the left ventricle and abnormal prominence of the pulmonary artery. The hilar and intrapulmonary vessels were engorged. Examination of the esophagus with barium swallow showed a well de-

finer oblique extrinsic pressure defect in the posterior esophageal wall above the aortic arch, without obstruction to barium flow. Figure 2 shows heart and aberrant subclavian defect.

*Comment.* This child presents the classical features of a patent ductus arteriosus—machinery murmur, slight somatic retardation, left ventricular and pulmonary artery enlargement and engorgement of hilar vessels. Routine roentgenoscopy un-

gitation on any but slow feeding and even at present feeding is slow. He had had three severe respiratory infections, each requiring hospitalization. Activities were partially limited by easy fatigue, but there was no dyspnea, orthopnea or edema and no cyanosis since the neonatal period.

Physical examination showed a thin and active child, quite small for his age, weighing 20½ lb. (average normal for age 29 lb.). Temperature 99.2° F., pulse 110, respirations normal.



FIG. 2. Case I. Aberrant right subclavian artery with patent ductus arteriosus: *A*, chest roentgenogram showing left ventricular enlargement, moderate prominence of the pulmonary artery segment and engorgement of hilar vessels. *B*, oblique roentgenogram of the esophagus showing the typical oblique extrinsic filling defect posteriorly above the level of the aortic arch.

covered an anomalous subclavian artery. Neither anomaly is producing important symptoms at present. Ligation and division of the ductus is planned in a year or so.

**CASE II** (Record No. 306,660). R. S., male, aged two years, seven months, entered the Children's Hospital on June 11, 1946, because of easy fatigue and failure to gain weight. Parents living and well; a four year old sibling is normal. Pregnancy was remarkable in that the mother had German measles when two months pregnant. Birth was somewhat premature; delivery was normal. The baby was cyanotic for the first five days after birth and congenital cataract was noted. In infancy development was delayed and he was considerably underweight. In early infancy there was easy regur-

gitation on any but slow feeding and even at present feeding is slow. He had had three severe respiratory infections, each requiring hospitalization. Activities were partially limited by easy fatigue, but there was no dyspnea, orthopnea or edema and no cyanosis since the neonatal period. Physical examination showed a thin and active child, quite small for his age, weighing 20½ lb. (average normal for age 29 lb.). Temperature 99.2° F., pulse 110, respirations normal.

Urine negative. Erythrocyte count 4 million with 12.5 gm. hemoglobin. Electrocardiogram showed sinus tachycardia, rate 140, with di-

phasic QRS in all leads; duration of QRS, however, was 0.09 second, within normal limits.

Roentgenographic and roentgenoscopic examination of the heart (X-ray No. A1179) showed it markedly enlarged to the right and left. There was considerable left ventricular hypertrophy, marked enlargement of the left atrium and abnormal fullness of the pulmonary artery segment. Right atrium also appeared enlarged. Left ventricle, pulmonary artery and

Patient was discharged, improved, on the fifteenth hospital day.

*Comment.* This child, whose mother had had German measles in the second month of pregnancy, showed multiple congenital defects including congenital cataract, probable defective tear duct, umbilical hernia, undescended testis, anomalous subclavian artery and a patent ductus arteriosus. The

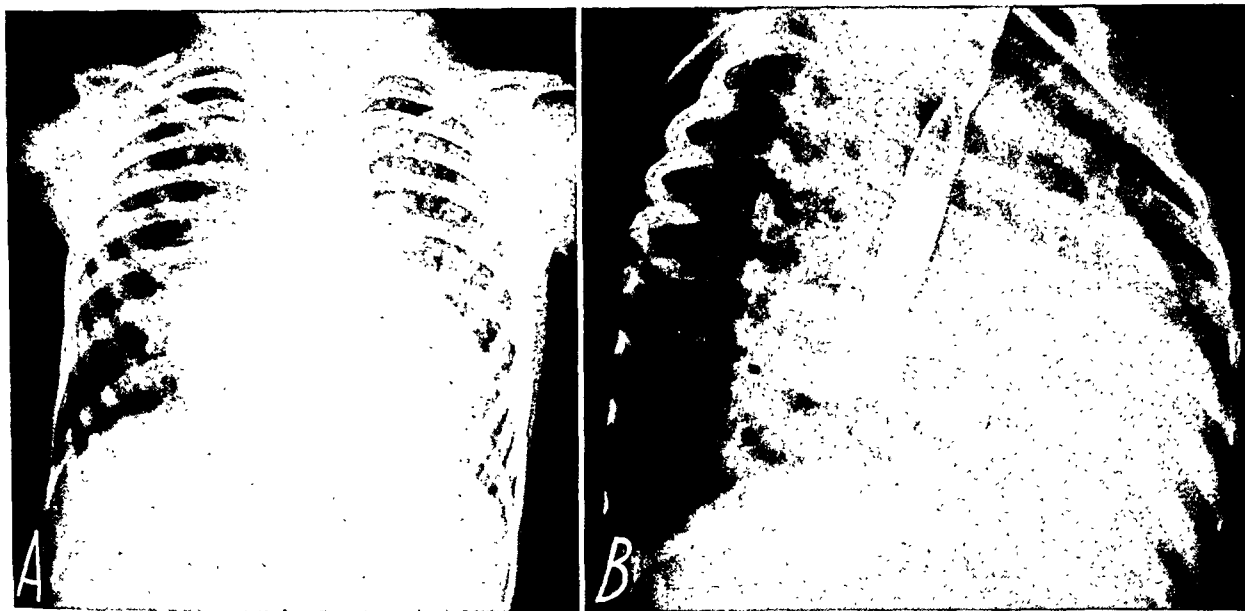


FIG. 3. Case II. Aberrant right subclavian artery with patent ductus arteriosus. *A*, chest roentgenogram showing cardiac enlargement to the right and left, left ventricular enlargement, fullness of the pulmonary artery segment and engorgement of hilar vessels. *B*, right anterior oblique roentgenogram of the esophagus showing the oblique posterior defect above the level of the aortic arch.

aortic arch showed markedly exaggerated amplitude of pulsation and the hilar vessels were engorged. Examination of the esophagus with barium swallow showed a posterior oblique extrinsic pressure defect indicative of an anomalous right subclavian artery (see Fig. 3).

Operation (Dr. Robert E. Gross) revealed a large patent ductus, estimated 8 mm. in length and 8 mm. in diameter. The ductus was ligated and divided. Confirmation of the aberrant subclavian vessel by exploration of the posterior mediastinum was felt to require too extensive dissection in this rather frail child.

On the seventh postoperative day roentgenographic and roentgenoscopic re-examination showed marked decrease in rate and amplitude of pulsation, both being then within normal limits. Barium swallow again demonstrated the characteristic oblique defect of an aberrant subclavian artery.

patent ductus was associated with considerable general cardiac enlargement and was presumably partly responsible for the inadequate somatic growth. The aberrant subclavian caused only minor feeding difficulty and its presence was unsuspected before its discovery by routine roentgenoscopy.

CASE III (Record No. 305,233). J. R., a female infant, aged one year, nine months, entered the Medical Outpatient Department on May 15, 1946, for investigation of a heart murmur discovered three months previously. The mother is being treated for lues, said to have been contracted from the father, a mechanic, after his return from the Armed Forces. During the second month of pregnancy the mother had a severe prolonged virus-like illness with fever and respiratory symptoms. Delivery was nor-



mal; there was no neonatal cyanosis. Motor and somatic development were normal. No actual dysphagia is known, but child is described as a "poor eater." She has had no cyanosis, dyspnea, weak spells or edema.

Physical examination showed a well developed and nourished baby girl weighing 26 lb. (normal for her age). No cyanosis. Skin, head, eyes, ears, nose and throat negative. Chest not abnormal. Heart appeared enlarged to the left. A loud blowing systolic murmur and a probable soft diastolic murmur were heard in the second interspace to the left of the sternum. No thrill palpable. Lungs were clear to percussion and auscultation. Abdomen and extremities negative. No clubbing present.

Blood Hinton test was reported negative.

Roentgenographic and roentgenoscopic examination of the heart (X-ray No. A627) showed slight total cardiac enlargement. Left ventricle and left atrium were enlarged, with marked prominence of the pulmonary artery segment. There was enlargement of the left ventricle and left atrium, with marked prominence of the pulmonary artery segment. There was strikingly exaggerated expansile pulsation of the pulmonary artery, amplitude of one border estimated at 1 cm. The hilar and pulmonary vessels were engorged. Examination of the esophagus with barium swallow revealed an oblique extrinsic pressure defect posteriorly, typical of an aberrant right subclavian artery.

*Comment.* This child, whose mother had a severe infection during the second month of pregnancy, had a loud systolic murmur in the pulmonic area and a probable faint diastolic as well (auscultatory findings in an infant of this age being often uncertain). There is roentgen evidence of an enlarged and markedly pulsating pulmonary artery. The ductus is probably a small one and no clinical effects are as yet evident. As in the previous 2 cases, routine roentgenoscopic examination revealed the additional roentgen picture of an aberrant subclavian vessel.

The following 2 cases are examples of congenital abnormality, other than patent ductus arteriosus, of the base of the heart and associated great vessels; each is accompanied by an anomalous subclavian artery.

CASE IV (Record No. 271,709). R. C., a male, aged four years, five months, was admitted to the Children's Hospital on December 13, 1945, because of recurrent hematemesis, five weeks in duration. He had had a previous admission in his second year because of a fractured skull followed by a right hemiplegia and gross congenital heart disease was noted as an incidental feature. There were no known familial diseases and pregnancy is not known to have been abnormal. Delivery was normal, at full term. Cyanosis was noted at birth. Cyanosis increased progressively and was constant during the past two years. Growth and development were somewhat retarded. There was no major feeding problem, but definite difficulty in swallowing full mouthfuls of semisolid foods is described.

Physical examination showed a deeply cyanotic, poorly developed male child with rapid labored respirations; temperature 98.6° F., pulse 120, respiration 50. Skin negative except for cyanosis. Head, eyes, ears, nose and throat not remarkable. Heart appeared enlarged to the right. No thrill was palpable, but there was a soft precordial systolic murmur. Lungs were clear to percussion and auscultation. Abdomen negative. Fingers and toes showed severe clubbing. Right arm was paralyzed, with a flexion deformity. Right leg weak. Reflexes elsewhere not remarkable.

Electrocardiogram showed right axis deviation. Urinalyses negative. Erythrocyte count 8.5 million. Hematocrit 74. Hemoglobin 21 grams per cent. Leukocyte count 16,700.

Roentgenographic and roentgenoscopic examination of the heart (X-ray No. 83942) showed the heart not enlarged by measurement, but with a grossly abnormal contour. The right ventricle showed considerable enlargement and there was narrowing in the left waist of the heart in the region of the pulmonary artery segment. The left ventricle also appeared enlarged and the aortic shadow was prominent. Lungs were clear. Examination of the esophagus by barium swallow showed a small oblique filling defect posteriorly at the aortic arch level, the appearance being that characteristic of an aberrant subclavian vessel (see Fig. 4).

On the eighth hospital day the patient was transferred to the Surgical Service. On the thirty-first day anastomosis of the innominate artery to the pulmonary artery was performed by Dr. Robert E. Gross. A to-and-fro murmur

in the pulmonic area appeared, cyanosis slowly decreased, polycythemia diminished and re-examination by roentgenograms and roentgenoscopy showed definite increase in the pulmonary vascular markings. Follow-up visits show a marked increase in well-being and ability to exercise.

*Comment.* This child presents the classic picture of the tetralogy of Fallot, confirmed by surgical exploration and markedly benefited by surgical anastomosis of the innominate artery to the pulmonary artery.

there has been undue fatigue after exercise, limiting activity somewhat.

Physical examination showed a fairly well developed female child weighing 40½ lb. (normal for age), temperature 98.6° F., pulse 90, respiration 24. No cyanosis. Skin, head, ears, eyes, nose and throat not remarkable. Chest normal in shape, except for questionable fullness over the precordium. There was a very loud basal systolic murmur with thrill; no diastolic heard. A2 and P2 were greatly diminished. Blood pressure 110/60. Lungs were clear to percussion and auscultation. Abdomen, genitalia

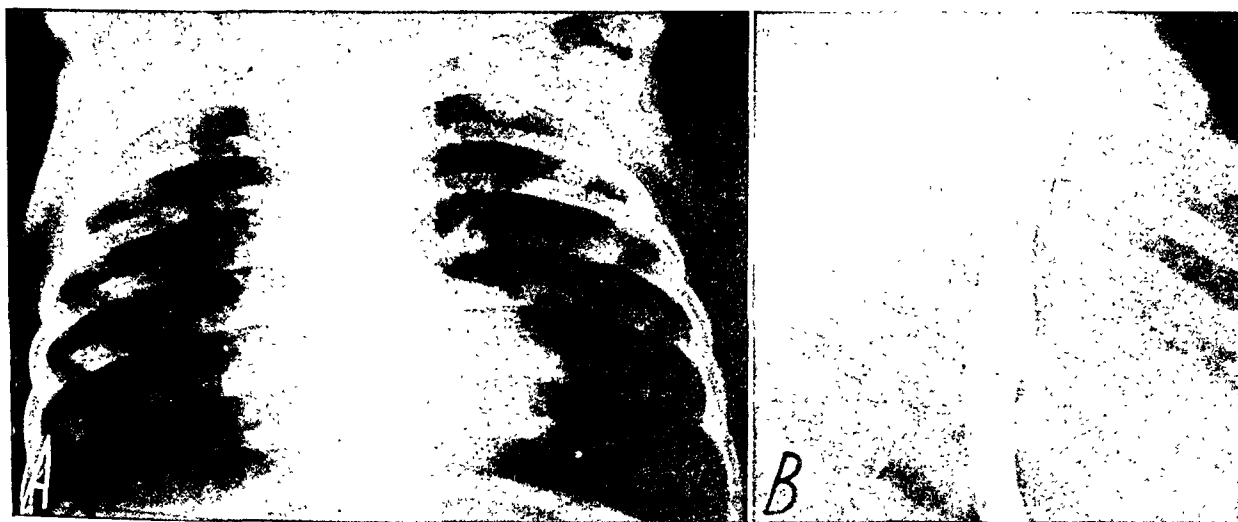


FIG. 4. Case IV. Aberrant right subclavian artery with tetralogy of Fallot. *A*, chest roentgenogram showing narrowing in pulmonary artery segment with elevation and displacement of the apex by right and left ventricular enlargement. *B*, lateral view of esophagus showing posterior defect above level of aortic arch.

An aberrant subclavian artery, which had produced mild dysphagia with solid foods, was discovered on routine roentgenoscopy.

CASE V (Record No. 299,718). D. B., a female, aged four years, eleven months, entered the Children's Hospital on November 14, 1945, for evaluation of her known congenital heart disease. There were no known familial diseases and two siblings were apparently normal. Mother had no known illness during pregnancy. Delivery was at term and was uncomplicated. There was a mild neonatal cyanosis which persisted throughout the first year of life and is now noted only during crying. Growth and development were within normal limits. There was no known dysphagia. In her second year she was hospitalized for three days for an unexplained episode of severe dyspnea. No other dyspnea is known and no edema. However,

and extremities were negative; no definite clubbing seen.

Urinalysis negative. Erythrocyte count 4.89 million; leukocyte count 5,400. Electrocardiogram showed right axis deviation.

Roentgenographic and roentgenoscopic examination of the heart (X-ray No. 97453) showed the heart at the upper limit of normal in size. The base of the heart was unusually wide, with a prominent pulmonary artery segment. The base of the heart showed widely expansile pulsation bilaterally, but the pulmonary artery showed a quiet beat. Examination of the esophagus with barium swallow revealed an oblique defect posteriorly characteristic of an anomalous subclavian artery (see Fig. 5).

Patient was discharged, without surgical therapy, on the third hospital day.

*Comment.* This child presents congenital

heart disease of uncertain structure. The cyanosis on effort, loud basal murmur and right axis deviation suggest an intracardiac shunt and the absent or diminished second sound in the pulmonic and aortic area suggest that the shunt lies somewhere at the base of the heart, perhaps at the origin of the pulmonary artery and aorta. However, from the roentgenologic picture an interauricular defeat could not be ruled out. Whatever the defect, it was believed that it

tus arteriosus. In addition, one example of the tetralogy of Fallot was seen and one congenital heart of indeterminate structure perhaps involving a basal intracardiac shunt.

Coexistent defects other than cardiac also occur. One patient (Case II), with history of German measles in the mother in the second fetal month, showed multiple minor congenital abnormalities in addition to the aberrant subclavian and a patent



FIG. 5. Case v. Aberrant right subclavian artery with congenital heart disease of undetermined type. *A*, chest roentgenogram showing abnormal widening of mediastinal shadow at base of heart and prominence of the pulmonary artery segment. *B*, right anterior oblique view of the esophagus showing the characteristic oblique defect posteriorly above the level of the aortic arch.

is not one at present amenable to surgery and exploration was not done. An asymptomatic aberrant subclavian artery was discovered during routine roentgenoscopy.

#### DISCUSSION

Anomalous subclavian artery, previously known as an isolated congenital deformity, apparently often occurs as one of several congenital defects, particularly congenital heart disease. These are usually abnormalities of the great vessels in or at the base of the heart. In the present series the deformity was most commonly a patent duc-

ductus. Anomalous right subclavian artery may now be added to the growing list of congenital defects known to follow maternal German measles in early pregnancy.

The combination of aberrant subclavian artery with congenital abnormality of the great vessels at the base of the heart is apparently a common one. The embryologic significance of this syndrome is not entirely certain. The embryologic mechanism involved in the formation of anomalous subclavian artery is well understood.<sup>1</sup> In the transformation of the aortic arches during the second fetal month, the

fourth arch is normally absorbed just proximal to its junction with the dorsal aorta; the remainder of the arch becomes the normal right subclavian.<sup>4</sup> In the anomaly, the proximal portion of the arch is resorbed instead; the portion of the arch which joined the dorsal aorta then constitutes the anomalous subclavian vessel.

In the case of the tetralogy of Fallot accompanying the anomalous subclavian, it is reasonable to suppose that both defects arose from the same disturbance of embryologic development. The dextroposed aorta, pulmonic stenosis and interventricular septal defect must have been produced at the same time as the aberrant subclavian artery; namely, in the second fetal month, during the processes of aortic arch transformation, differentiation of pulmonary artery and ventral aorta and development of the cardiac septa.

In the case of patent ductus arteriosus, however, there is no evidence to suggest that fetal abnormality during the second fetal month influences the complex process of closure of the ductus normally initiated at birth. Only a few of the factors in normal ductus closure are known.<sup>2</sup> Tension and torsion produced in the ductus region by the anomalous subclavian origin might conceivably exert a mechanical effect on the ductus. However, it appears improbable that a mechanical factor alone could prevent the subintimal connective tissue proliferation that constitutes normal ductus closure.<sup>3</sup> Impaired neonatal oxygenation has been recently invoked as one cause of persistent patency of the ductus arteriosus, but it is difficult to conceive that the mere presence of an aberrant subclavian artery could significantly affect neonatal oxygenation.

The embryologic relations between anomalous subclavian artery and patent ductus arteriosus therefore remain uncertain. Although the mechanism is not known, it is difficult to believe that the two processes are entirely coincidental. It is far more probable that they are both manifestations of a basic fetal abnormality,

induced in at least some cases by virus disease in the early months of pregnancy.

#### SUMMARY

Anomalous right subclavian artery in infants is often accompanied by congenital anomalies of the great vessels at the base of the heart. Five cases of this syndrome are reported; three were cases of patent ductus arteriosus; one, a tetralogy of Fallot; and one, a congenital cardiac anomaly of uncertain structure.

In one of the cases of anomalous subclavian artery with patent ductus arteriosus, German measles in the mother in the second month of pregnancy was the evident cause of the congenital abnormalities.

The roentgenologic features of anomalous right subclavian artery, and of patent ductus arteriosus are reviewed. The value of a routine barium swallow during roentgenoscopic examination of the heart and lungs is emphasized.

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# ROENTGENOLOGIC PULMONARY MANIFESTATIONS OF FATAL HISTOPLASMOSIS\*

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IN RECENT years, various investigators<sup>1,5,7,8,11,12</sup> have suggested that the pathogenic fungus, *Histoplasma capsulatum*, is the cause of certain instances of calcification occurring within the lungs and mediastinal lymph nodes. Although final proof of this hypothesis is not yet available, the basic significance of the observation as it now stands should not be minimized. Anyone who has attempted to rationalize repeated negative tuberculin reactions in patients with unmistakable roentgen signs of hilar and parenchymal calcium deposits can best appreciate the implications of this noteworthy contribution.

As we await additional information regarding the true role played by *Histoplasma capsulatum* in the production of clinically unimportant intrathoracic calcium deposits, it is perhaps well to recall that histoplasmosis can be a serious and frequently fatal disease involving the lungs, any or all of the abdominal viscera, the skin, the mucous membranes, the lymph nodes, the bone marrow and occasionally other portions of the body.<sup>4</sup> Furthermore the disease appears to be increasing in frequency—at least in certain areas. Parsons and Zarafonitis,<sup>9</sup> in a comprehensive review of the subject, tabulated 71 cases, 54 of which occurred between 1938 and 1943; this despite the fact that Darling<sup>3</sup> first described the disease in 1905. The great majority of the cases reviewed proved fatal, 56 were autopsied and, of this group, 34 had demonstrable pulmonary lesions.

Histoplasmosis is notoriously difficult to diagnose by clinical methods, and therefore it is logical to search for some reliable roentgenologic clue which might serve to identify the process more accurately. As

pulmonary involvement is such a common manifestation of the disease, the attention is naturally directed toward the roentgenogram of the chest.

Nine patients with histoplasmosis which eventually proved fatal were seen at the University of Michigan Hospital between 1938 and 1946, and 5 of them had definite pulmonary involvement proved by autopsy. Four of these patients have been reported elsewhere by Parsons and Zarafonitis,<sup>9</sup> Kemper and Bloom,<sup>6</sup> Seabury and Drygas,<sup>10</sup> and Curtis and Grekin.<sup>2</sup> It was thought that a supplementary presentation of the chest roentgenograms of this group of patients might be of some interest from the diagnostic viewpoint, especially since no reproductions of roentgenograms were utilized in the previous publications. Only brief case summaries of these patients are included. For more complete clinical and laboratory data concerning them, the interested reader is referred to the articles mentioned above.

One patient (Case v) is reported herein for the first time.

## CASE REPORTS

CASE I. A. J. W., a white male, aged forty-one, entered University Hospital on August 6, 1940, having as his chief complaints fever and weakness. He gave a history of having had swelling of his neck which his local physician had found to be due to enlarged lymph nodes. These allegedly had responded promptly to roentgen therapy, but weakness and lassitude had persisted.

On physical examination, a few small cervical and axillary lymph nodes were felt, the liver and spleen were found to be enlarged and widespread rales were heard in both lungs. A tentative diagnosis of lymphoblastoma was made.

Roentgenograms of the chest on August 8, 1940, showed bilateral hilar adenopathy and

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widespread fine granular lesions in both lungs (Fig. 1A). Parenchymal involvement was most pronounced in the perihilar regions. The findings were thought to be compatible with the clinical diagnosis of lymphoblastoma.

Review of a histologic section made from a lymph node removed at another hospital showed lymphoblastoma of the lymphosarcoma type.

Between August 8 and August 20, 1940, the patient received 400 roentgens to each of eight fields around the chest and in the retroperitoneal region, but his condition grew progres-

Nothing was found to support the antemortem diagnosis of lymphosarcoma.

CASE II. M. K., a white male, aged sixty, was admitted to the University Hospital on January 18, 1943, for treatment of an indolent ulcer on his tongue. Roentgenograms of the chest taken on January 23, 1943, were negative, but in March patchy pneumonitis was observed in the right lower and right middle lobes (Fig. 2A). This cleared within the space of a few weeks, but was supplanted by a similar process



FIG. 1. Case I. A, bilateral miliary parenchymal lesions and hilar adenopathy of indeterminate etiology. B, marked extension of pulmonary abnormalities two days before death. Autopsy showed histoplasmosis.

sively worse and death occurred on August 26, 1940. Re-examination of the chest (bedside roentgenogram) two days before death showed increase in prominence of the hilar shadows. The previously described fine granular lesions in the lung now appeared as considerably larger patches of parenchymal infiltration widely disseminated throughout both lungs (Fig. 1B).

At autopsy, there was evidence of widespread subacute pneumonitis, acute pulmonary abscesses, chronic pulmonary edema and an acute fibrinopurulent exacerbation of chronic bronchitis. Numerous small encapsulated organisms morphologically like *Histoplasma capsulatum* were found within large mononuclear phagocytes in the alveoli. There was also involvement of bronchial lymph nodes, liver, adrenals, stomach, ileum, appendix and bone marrow.

at the base of the left lung. On June 1, 1943, chest roentgenograms showed granular pneumonitis in the lower portions of both lungs, especially the right (Fig. 2B). In the meantime, the ulcer on the patient's tongue became larger, and additional granulomatous lesions developed in the pharynx and larynx producing severe dysphagia and complete aphonia. The patient's general condition continued to grow progressively worse and death occurred on July 16, 1943.

At autopsy, multiple fine nodular lesions were grossly observed throughout both lungs. A fibrous nodule, 1 cm. in diameter, was found in the right upper lobe, and a small area of atelectasis was seen in the right lower lobe. Microscopically, most of the fine nodular lesions appeared to be small, irregular masses

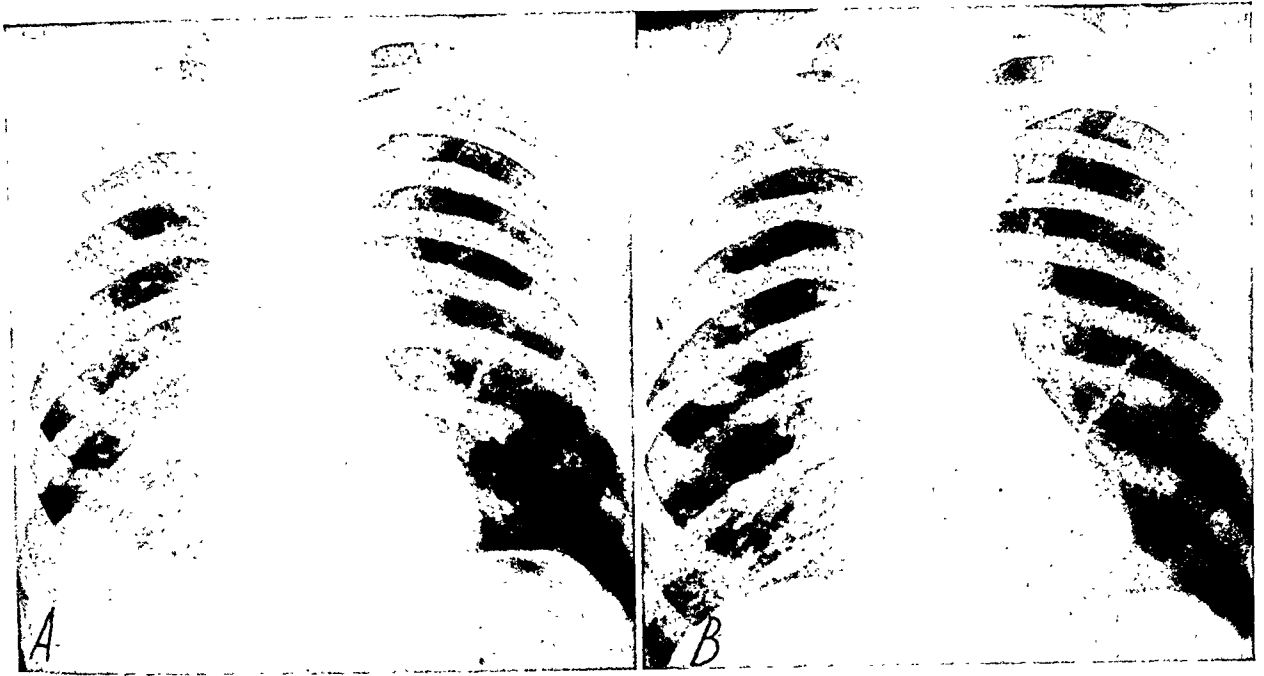


FIG. 2. Case II. *A*, patchy pneumonitis at right base which regressed and later recurred in the form of coarse granular lesions shown in *B*. Note curvilinear scar in left lung. Autopsy showed bilateral histoplasmosis.

of connective tissue containing considerable anthracotic pigment. A few well circumscribed nodules consisted of large mononuclear phagocytes surrounded by lymphocytes, and in the center of these lesions giant cells were found. An occasional *Histoplasma capsulatum* was identified in both the phagocytes and the giant cells.

Additional organisms were found in the heart, the bone marrow and the ulcerating lesions of the mouth and throat.

CASE III. R. Y., a white male, aged fifty-five, first entered the hospital on June 2, 1943, complaining of perineal pain on defecation, and recent chills and fever. A partial gastrectomy had been done elsewhere in January, 1943, for suspected gastric ulcers; pathologic diagnosis made from the operative specimen was "sub-acute purulent gastritis."

A barium enema and sigmoidoscopy on June 7, 1943, showed narrowing and irregularity of the rectum due to an extraluminal mass. When histopathologic examination of a biopsy specimen showed no evidence of neoplasm the patient was discharged and treated conservatively by his local physician with excellent temporary results.

Recurrence of the patient's chills and fever accompanied by cough and sputum prompted him to return to the hospital on December 8, 1944. On this occasion, chest roentgenograms

showed extensive solidification of the base of the right upper lobe, the over-all appearance suggesting unresolved pneumonia (Fig. 3). Barium administered by mouth outlined a persistent deformity of the lower esophagus and the upper three-fourths of the stomach, indicating the presence of either an infiltrating neoplasm or some constricting extra-alimentary mass. Barium enema showed the previously



FIG. 3. Case III. Solidification of base of right upper lobe due to histoplasmosis which eventually proved fatal.



described rectal narrowing to have completely disappeared.

Bronchoscopy on December 22, 1944, was negative. The patient's condition rapidly became worse and death occurred on December 24, 1944.

Autopsy was done and histoplasmosis was found involving the right lung, liver, spleen, kidney and bone marrow. There was a severe paraesophagitis with partial obstruction of the lower esophagus but no obvious involvement of the stomach. The residuum of an old perirectal abscess was identified.

CASE IV. F. F., a white female, aged thirty, was admitted to the hospital on September 11,

of roentgenograms exposed at another hospital showed the chest to be normal in appearance on January 20, 1944, and March 7, 1944. Another chest roentgenogram from the same source dated April 20, 1944, showed minimal right hilar lymph node enlargement and questionable patchy parenchymal infiltration in the lower half of the right lung.

Biopsies of leg and scalp ulcers on September 13 and 19, 1944, were reported as showing a chronic infective granuloma, and, although no definite diagnosis was made from the biopsies, histoplasmosis was suggested as a strong possibility.

Considerable regression of the right hilar

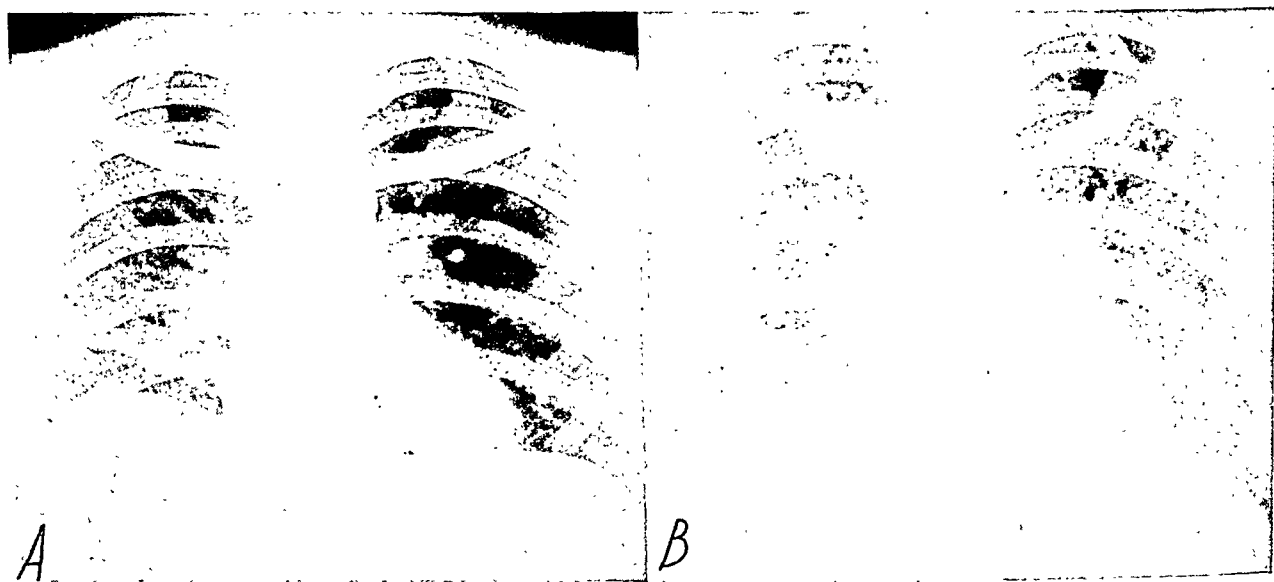


FIG. 4. Case IV. *A*, linear densities in right lower lobe thought to be due to atelectasis. Residual right hilar adenopathy. *B*, persistence of linear densities at right base and widespread dissemination of granular lesions throughout both lungs. Both histoplasmosis and tuberculosis were found at autopsy.

1944. Her outstanding symptoms consisted of a productive cough, fever, weight loss and multiple ulcerating soft tissue swellings of the forehead, neck and the extremities. Physical findings referable to the chest included dullness to percussion at the base of the right lung anteriorly, and rales at both lung bases. The provisional clinical diagnosis on September 12, 1944, when the patient was first referred to the Department of Roentgenology was blastomycosis.

Stereoscopic frontal and single lateral roentgenograms of the chest showed right hilar adenopathy, faint, patchy pneumonitis of the right lung and questionable additional pneumonitis of the left lung. The etiology of these changes was considered indeterminate. Review

adenopathy and the bilateral pneumonitis was observed on University Hospital roentgenograms of October 17, 1944 (Fig. 4*A*), and there was now evidence of linear atelectasis at the base of the right lung suggesting subdiaphragmatic abnormality. These linear shadows persisted on check-up examinations of November 7, 1944, and January 22, 1945.

The patient was readmitted to the hospital on February 24, 1945, with increase in the severity of her original symptoms and with the additional finding of mild clubbing of the fingers. Chest roentgenograms on this date showed a remarkable change when compared with previous roentgenograms. Multiple areas of increased density were seen widely disseminated throughout both lungs from the apices to the

bases. In some regions the lesions appeared small, discrete and granular; elsewhere they were larger and poorly defined (Fig. 4B). The roentgenographic picture was not thought to be characteristic of any single disease entity, but the diagnosis became evident on the following day (February 25, 1945) when direct examination of the patient's sputum showed intracellular *Histoplasma capsulatum*. It is also of interest to note that inoculation of a guinea pig with the patient's sputum eventually resulted in isolation of acid-fast bacilli typical of *Mycobacterium tuberculosis*.

foci. The organisms of *Histoplasma* were also found in the brain, liver, spleen, bone marrow and oviducts.

CASE V. M. L. H., a white male, aged forty-two, entered University Hospital on April 28, 1945, on the service of Dr. H. M. Pollard. The patient's chief complaint was fever. He gave a history of a chronic cough of five years' duration which only during the past year had been productive of mucoid sputum. Two weeks prior to his admission to University Hospital, he developed pain and stiffness in the back of his neck.

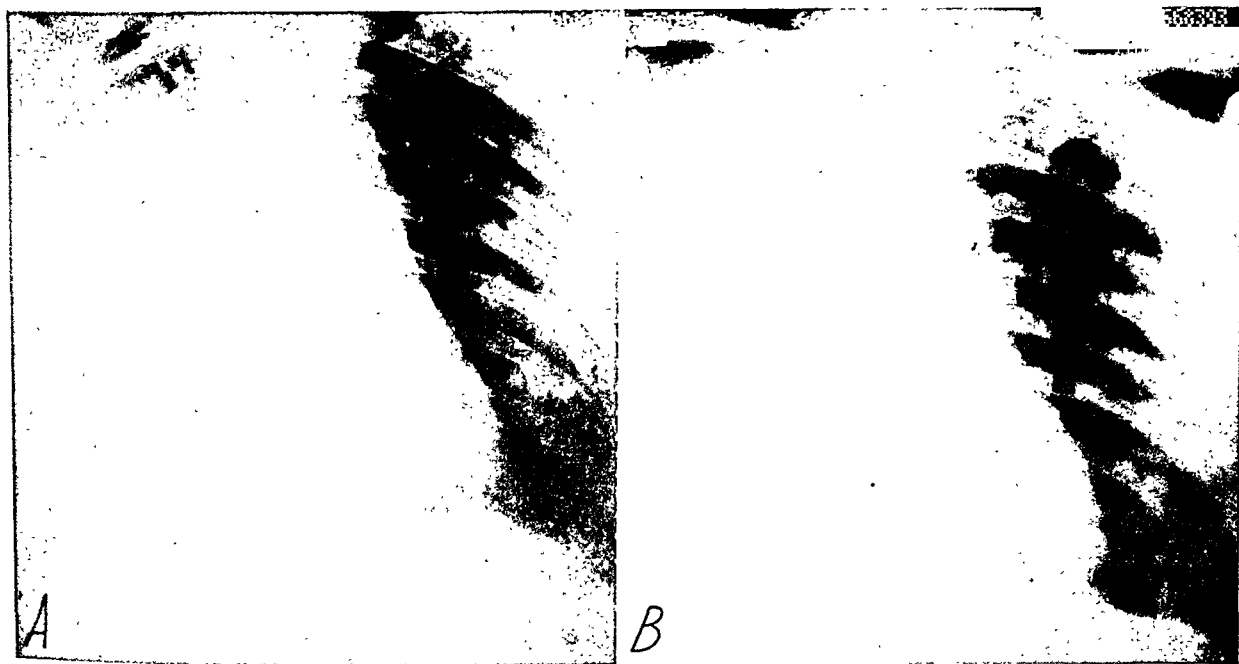


FIG. 5. Case v. A, extensive abnormality of right lung associated with moderate pleural fluid accumulation on the same side. B, two days later. Right hemithorax now completely obscured by homogeneous increase in density, presumably massive effusion. Autopsy showed complete consolidation of the right lung resulting from histoplasmosis.

Death occurred on March 3, 1945, and autopsy revealed widespread histoplasmosis and tuberculosis. Gross examination of the lungs showed "innumerable, small, miliary-sized grayish-white, firm lesions" extensively distributed bilaterally. Numerous small cavities were found in both lungs. Microscopically, there was "very extensive granulomatous pneumonitis with extensive foci of caseation necrosis surrounded by epithelioid cells." In addition there was diffuse exudative and productive pneumonitis extending over large areas. Multinucleated giant cells occurred in a few of the lesions but none of these foci closely resembled tubercles. *Histoplasma capsulatum* was present in enormous numbers in the granulomatous

This was accompanied by shaking chills, nausea, vomiting and hallucinations.

Physical examination showed a semi-comatose, irrational man whose temperature was 103.6° F., pulse 124, respirations 22 and blood pressure 128/72. There was questionable nuchal rigidity but no papilledema. The right side of the chest was flat to percussion, decreased breath sounds were heard beneath the right clavicle and coarse, moist rales were present over the entire left lung. There was no clubbing of the fingers.

The urine examination showed 2+ albumin and occasional red and white blood cells. The blood count was within normal limits. Blood Kahn reaction was negative. Repeated sputum

examination showed numerous cocci; no acid-fast organisms. Serosanguineous fluid obtained by thoracentesis was cultured, but only an organism of the *Hemophilus* group was grown. Agglutination tests for typhoid, paratyphoid and brucella were negative.

A bedside roentgenogram of the chest made the same day the patient entered the hospital showed a poorly defined, somewhat rounded area of abnormal parenchymal density in the right upper lung (Fig. 5A). This area measured about 12 cm. in diameter, and there was questionable evidence of cavitation in its center. The lower portion of the right lung was partially obliterated by a homogeneous shadow of increased density. The findings were thought to be most suggestive of a right upper lobe lung abscess with associated pleural fluid accumulation on the right. Patchy pneumonitis was seen in the lower portion of the left lung. Two days later, another roentgenogram showed complete obliteration of the right hemithorax. This was thought to be due to massive pleural fluid accumulation, although the possibilities of massive consolidation or atelectasis of the right lung were also considered (Fig. 5B).

The final clinical diagnosis was chronic pulmonary granuloma of indeterminate etiology with toxic psychosis and meningismus. The patient remained in an agitated type of coma and death occurred on May 5, 1945.

Autopsy showed histoplasmosis of the lungs, lymph nodes, liver, spleen and adrenals. The right lung was completely consolidated and the left lung contained numerous nodules measuring 4 to 12 mm. in diameter as well as a larger area in the left lower lobe which appeared somewhat caseous. Microscopic sections showed "widespread seropurulent and necrotizing pneumonitis with caseation necrosis in some areas. There is no tubercle formation, and staining for acid-fast organisms has been consistently negative. Around the borders of the caseous areas there are numerous macrophages with basophilic inclusions which are believed to be *Histoplasma capsulatum*."

#### COMMENT

It is evident, in our limited experience, that an antemortem diagnosis of pulmonary histoplasmosis based solely upon roentgenologic findings has not been possible. A quick perusal of the chest roentgenograms reproduced in Figures 1 to 5 will

show that a more diversified group of pulmonary changes scarcely could be found in any disease or group of diseases even if one deliberately attempted to do so. Although very few illustrations of chest roentgenograms showing pulmonary histoplasmosis appear in the medical literature, a review of various authors' descriptions of roentgenographic findings in their respective case reports clearly indicates that our own antemortem diagnostic difficulties have been in no way unusual. Perhaps the most consistent finding has been the occurrence of widespread granular lesions extensively disseminated throughout both lungs such as were seen in Cases I and IV. This miliary spread is usually a terminal manifestation, however, and is of little help in diagnosing the early stages of the disease. Furthermore, it is well known that disseminated granular lesions in the lung are notoriously difficult to classify roentgenologically. Thus one can merely add this form of histoplasmosis to the differential diagnosis of a long list of disease entities which includes miliary tuberculosis, pneumoconiosis, sarcoidosis, lymphoblastoma, bronchopneumonia, lymphogenous pulmonary metastases, numerous fungus infections and many other conditions.

It has been well established that histoplasmosis and tuberculosis occur together relatively frequently, and there is ample evidence to indicate conclusively that both diseases will produce cavitation in the lung. These facts obviously make the problem of diagnosis even more difficult than would otherwise be the case. This is well exemplified by our Case IV. *Histoplasma capsulatum* was observed in a direct smear of the patient's sputum six days before death, and *Mycobacterium tuberculosis* was isolated several weeks post-partum from a guinea pig which had been inoculated with the same sputum. Autopsy showed multiple cavities and numerous organisms of *Histoplasma* in the patient's lungs, but neither definite tubercles nor tubercle bacilli were found in these structures.

Although histoplasmosis affects persons

of all ages, its relatively high incidence in the fifth, sixth and seventh decades of life makes differentiation from bronchogenic neoplasm a difficult problem for the roentgenologist. This is particularly true when the disease manifests itself as in Case III or Case v. Although the clinical signs and symptoms in these patients were not indicative of neoplasm, the roentgenologic findings were so suggestive of this abnormality that bronchoscopy was required for more accurate evaluation.

#### SUMMARY

The roentgenologic pulmonary findings as well as brief clinical and pathologic reports of five patients with fatal generalized histoplasmosis are presented. One of these cases is reported for the first time; the others are included as a roentgenologic supplement to previous University of Michigan publications.<sup>2,6,9,10</sup> Analysis of the findings in these five patients indicates that the pulmonary changes in histoplasmosis are fully as varied as the clinical manifestations of the disease. Thus histoplasmosis belongs to that relatively large group of pulmonary diseases in which the roentgenologist must be content to identify the presence of abnormality, to determine its extent, to describe certain features regarding its appearance, and to offer various suggestions regarding its etiology without arriving at a definite diagnosis. The possibility of *Histoplasma capsulatum* as the etiologic agent of chronic pneumonitis should be particularly mentioned when widespread, coarse, granular, parenchymal lesions are encountered.

Final diagnosis of histoplasmosis depends upon various laboratory procedures all of

which are directed toward identification of the causative organism—a yeast-like fungus characteristically found in the cells of the reticulo-endothelial system.

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# THINNESS OF PARIETAL BONES

## REPORT OF A CASE HAVING PREDOMINANTLY UNILATERAL INVOLVEMENT

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SINCE the reports by Camp and Nash<sup>1</sup> and by the author,<sup>4</sup> there have been no contributions to the literature dealing with this subject. Inasmuch as the condition is bilateral and symmetrical in the majority of cases, and because there have been no publications referring particularly to unilateral thinness, the following case is reported.

The patient was a white male, aged eighty-eight, employed at the time of his injury in loading ice. While waiting on a customer everything suddenly "went black" and he collapsed, fell from the side of the platform on which he was working a distance of about 4 feet to the ground and received a stellate scalp wound on the left side of his skull in the posterior parietal region. On admission to St. Mark's Hospital he was unconscious but partially recovered in a short time and by the following day was mentally clear.

Inquiry relative to the body systems elicited no admission of abnormality of any nature. The only admitted past illness was the removal of a small "skin cancer" from the dorsum of his left hand in 1944; no sections were made. There was no evidence of regional metastasis or of local recurrence.

Blood pressure was 160/88. Temperature, pulse and respiration were normal on admission and during his stay in hospital. The eyes showed some A-V nicking and minimal silver-wire streaking of the vessels. He had a small umbilical hernia; bilateral indirect inguinal herniae were controlled by a truss. The prostate was enlarged to about double normal size but was soft and smooth. Neurological investigation showed complete left nerve deafness, but the cranial system was otherwise normal. The biceps, triceps, patellar and Achilles reflexes were increased on the right side. A positive right Babinski on admission became negative three days later. Hoffman, abdominal, cremasteric, Gordon and Oppenheim reflexes were absent. The grip of the right hand was slightly less strong than the left. There was no interference

with light touch, pain, temperature, vibratory or proprioceptive sensations.

In addition to the stellate left parietal scalp wound, there was flattening of the right parietal area of the skull. This presented, to palpation, as an indentation to the right of the midline.

The margins were smooth, its dimensions were approximately 3 by 5 cm., and one gained the impression of a firm bony floor through the overlying soft tissues. There was no tenderness to palpation and the color and texture of the overlying skin were the same as elsewhere in the scalp.

Laboratory investigations showed no abnormal findings other than an occasional epithelial cell and occasional granular casts in voided urine. The erythrocyte count was 4,290,000; leukocyte count 8,600; hemoglobin 13.0 grams; the differential white count was normal. Alkaline and acid phosphatase were respectively 7 and 3 Bodansky units. Inorganic phosphorus was 4.0 mg. and blood calcium was 10.45 mg.

Roentgen examination of the skull (Fig. 1 and 2) showed no evidence of fracture. On the right side in the parietal region, about 4 cm. from the midline, there was a shallow excavation which measured about 3 by 5 cm. It was seen best in the fronto-occipital projection but was also discernible in lateral view. Its margins were smooth, its floor approached but did not invade the inner table, and there was no evidence of roughness or of bone particles in the overlying soft tissues or within the cranium. The scalp margin, opposite the depression, was smooth and very slightly indented; the thickness of soft tissues was very slightly greater over the involved area than on the opposite side. In the corresponding region on the left side there was barely perceptible flattening but the definite saucerization seen on the right was not present.

Studies of the dorsal and lumbar spine showed extensive osteophyte formation and almost complete fusion of the twelfth dorsal and first lumbar vertebrae. The abdominal blood vessels showed arteriosclerotic calcification. Nothing suggestive of abnormality due to injury, inflammation or neoplasm was seen.



FIG. 1. Right lateral roentgenogram of skull showing radiolucent area just posterior to coronal suture line.

The patient was admitted to the hospital on March 15, 1946 at 2:30 P.M. and discharged on March 21, 1946, at 10:00 A.M. His chief complaint of dizziness on admission gradually cleared during the hospital stay. Wound healing was prompt and uncomplicated, and at the time of discharge he was in good physical condition, but because of the nature of his injury and his age he was advised to remain off work for two weeks. The discharge impression was (a) hypertensive arteriosclerosis, (b) benign prostatic hypertrophy, (c) umbilical hernia, (d) bilateral indirect inguinal herniae, (e) traumatic laceration of scalp from a fall judged to be due to a cerebral accident, (f) thinness of right parietal bone.

#### COMMENT

Unilateral thinness of the parietal bone is much less common than bilateral. Camp and Nash found 8 examples in the 119 cases which they reported. According to Sauvage<sup>3</sup> the involvement is not always exactly symmetrical, and in cases showing differences, the thinness is generally more marked on the right side than on the left. The left side involvement in the case presently reported was so slight as to be barely discernible.

The etiology of this condition is still obscure and in light of our present knowledge the dysplasia theory advanced by Greig<sup>2</sup> is the most plausible. It is to be

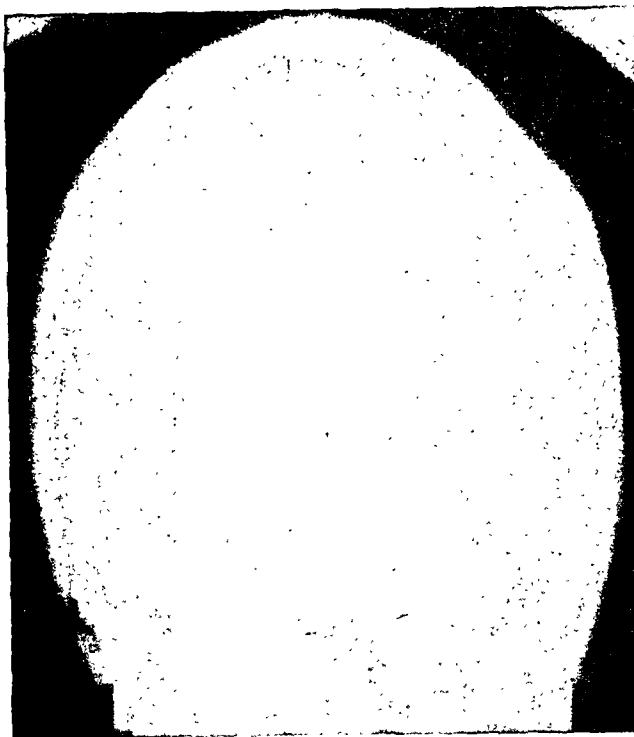


FIG. 2. Basal projection (fronto-occipital) showing saucer-like depression.

noted that blood studies in this case were within normal limits, hence an actively destructive bone process is unlikely.

I believe the reasoning of Camp and Nash to be sound, and agree with them that until we have more exact knowledge of etiological factors, the condition should be designated simply as "parietal thinness."

The author is indebted to Drs. Paul A. Pemberton and J. E. Day, attending physicians, for permission to report this case; to Drs. S. A. Wright and S. T. Mullican for neurological and physical investigations; and to Dr. Orin A. Ogilvie for laboratory studies.

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# VARIATIONS IN THE POSITION OF THE AZYGOS SEPTUM AND ITS INCIDENCE IN FIFTY THOUSAND ROENTGEN EXAMINATIONS

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SOME attention has been given to a division of the right upper lobe of the lung in the anatomical and roentgenological literature.<sup>1,5,7,11,15</sup> This division caused by an aberrant position of the azygos vein and the pleural coverings adjacent to it has generally been considered an anomaly of

in the case of the true lobes. It is therefore an anomaly of septation rather than of lobation. However, roentgenologically, the appearance is that of an accessory lobe and it has been so generally considered.

To the septum Hjelm and Hultén<sup>6</sup> applied the term meso-azygos and the curved

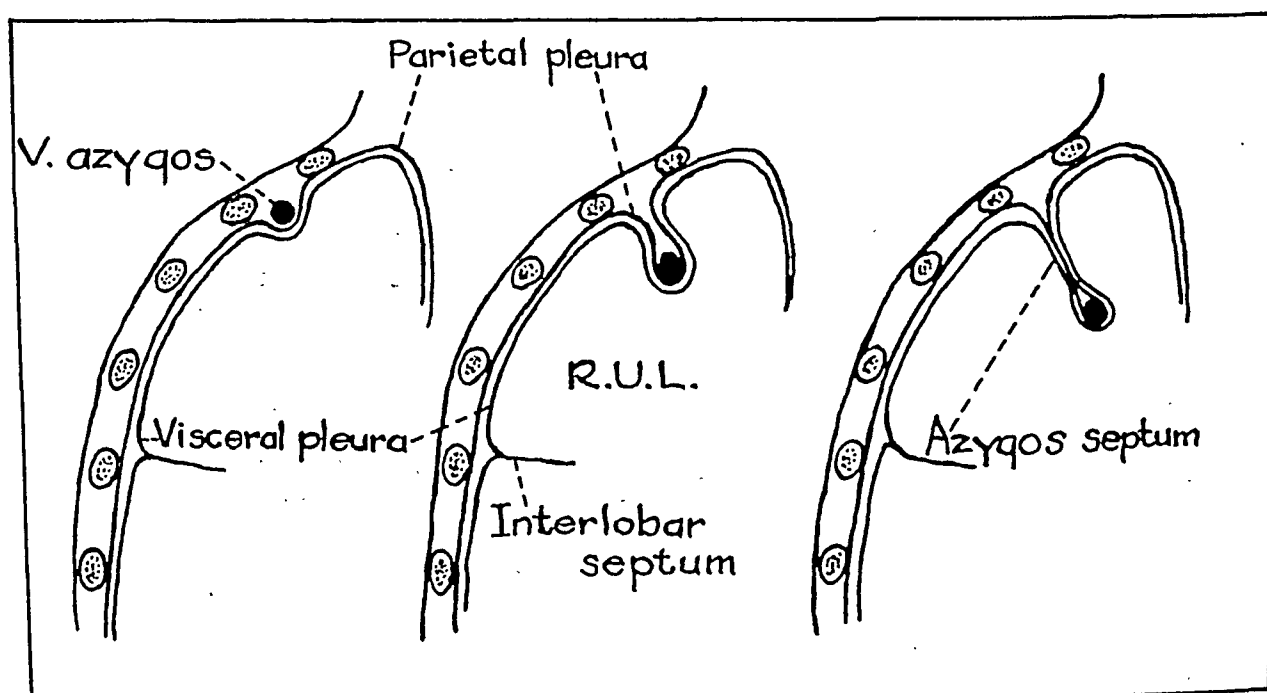


FIG. 1. Diagrammatic representation of the stages in the development of the azygos septum by invagination of the parietal and visceral pleurae by the azygos vein, resulting in formation of a septum having four distinct layers of pleura as contrasted with the true interlobar septum which has only two layers of visceral pleura. Note that the septum is lined with parietal pleura and covered externally by visceral pleura.

lobation and therefore called the azygos lobe. But the dividing partition or septum is made up of four thicknesses of pleura, two layers each of parietal and visceral pleura, unlike an ordinary lung septum which is composed of only two layers of visceral pleura. It is supplied by a division of the eparterial bronchus and not by a separate branch from a main bronchus as

linear shadow at the right apex was first shown by Bendick and Wessler<sup>2</sup> and confirmed at autopsy to be the meso-azygos. This curvilinear shadow had been described previously<sup>14</sup> but its significance was not understood. A clear description of the anatomical features is given by Underwood and Tattersall<sup>13</sup> essentially as follows: In fetal life the vena azygos major courses up

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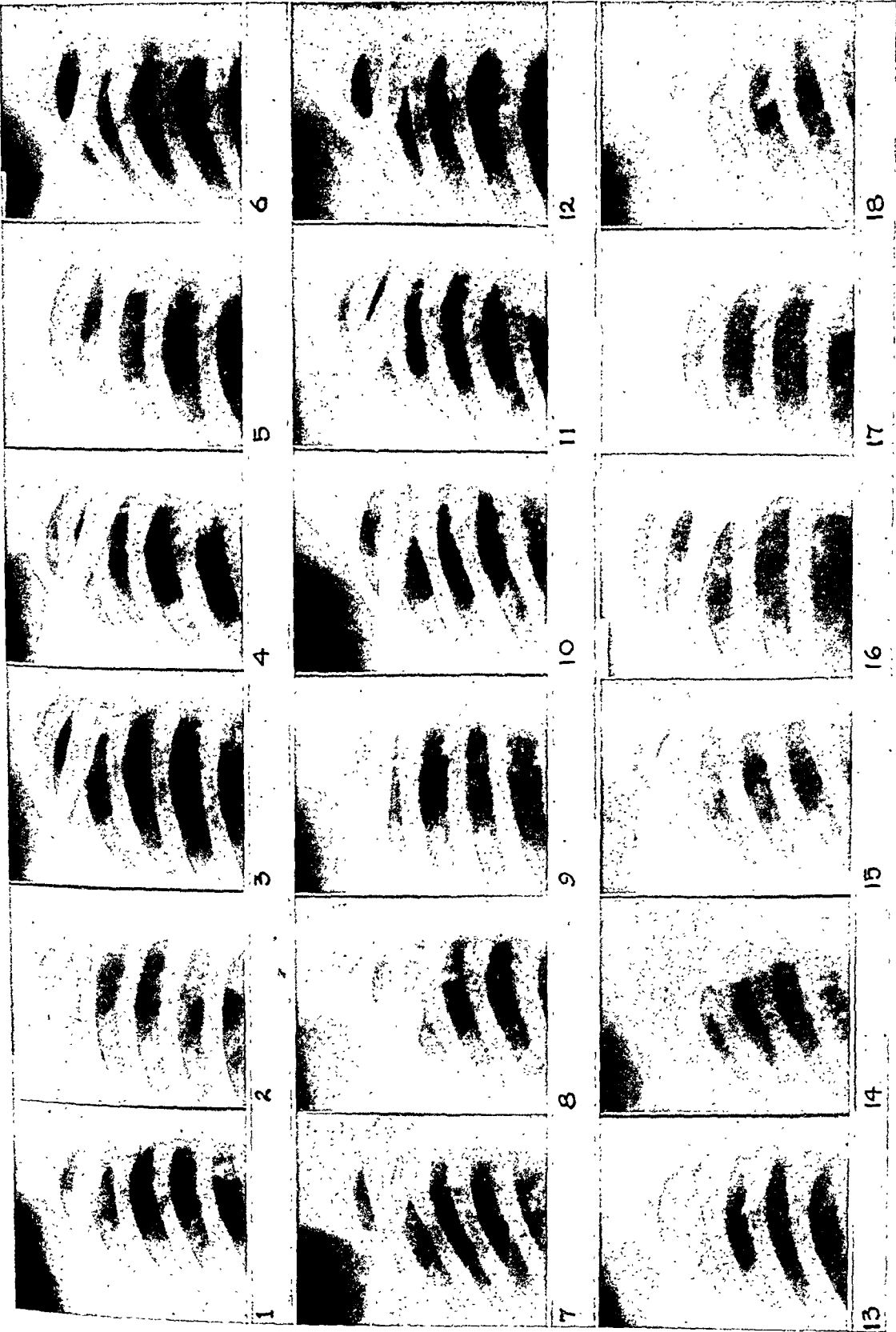


FIG. 2. Reproductions of photoroentgenograms showing extremes of variation in position of the azygos vein and septum. In the top row are shown paramedial positions with the septum and vein easily confused with mediastinal structures; in the middle row the more typical medial position with the well-known "comma" or "tear-drop" appearance of the vein, and in the bottom row lateral positions of the septum with atypical falciform shadows of the vein. Film No. 16 shows the septum having appearance of a thickened strand in a case of reinfection phase tuberculosis of the right apex.



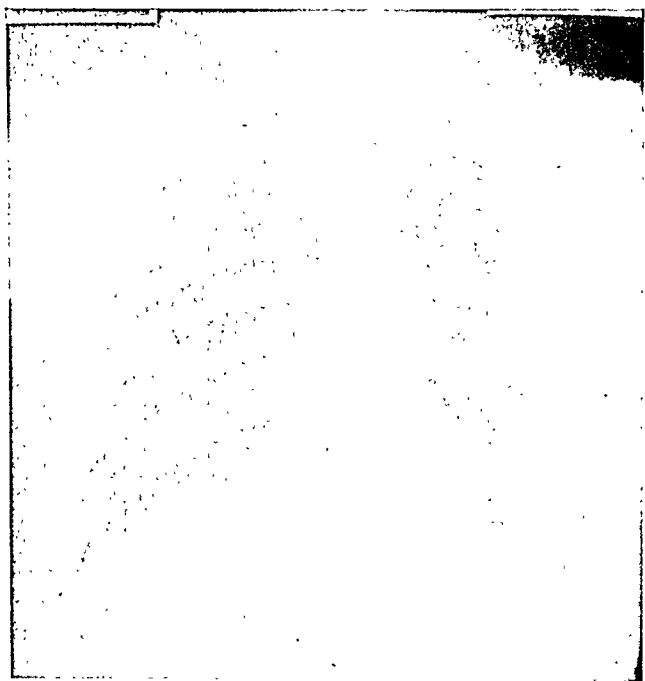


FIG. 3. Azygos septum in paramediastinal position having the appearance of a mediastinal mass.

the posterior mediastinum and arches over the root of the right lung to enter the superior vena cava on its posterior aspect. When, abnormally, the lung except the root lies more lateral, the vein instead of pursuing a vertical course in its lower portion, runs more laterally so that it cuts into the apex of the right lung and then turns medially to enter the superior vena cava on its lateral aspect. Normally the junction between the two veins lies at about the level of the second anterior intercostal space but the abnormally placed vein usually enters the vena cava at a higher level about the plane of the first interspace. The azygos vein normally lies outside both layers of the pleurae and carries with it when displaced forward into its abnormal position in the thorax both the visceral and parietal layers. As the vein pushes inward there is then formed a septum in the lung lined with two layers of parietal pleura (Fig. 1). The vein lies in the pocket formed at the base of the septum and, as can be seen in the roentgenograms shown herewith (Fig. 2), may have a variety of configuration from that of the typical "tear-drop" or "comma" shape to a rod or falciform shadow.

In this series of 50,000 consecutive roent-

gen examinations† a marked variation in the position of the vein and septum was observed. It was seen to vary from as far lateral as the outer third of the right thorax to a position so close to the right mediastinal border as to be scarcely distinguished from it (Fig. 2, 2, 3, 4, 5). In one case, in the medial position, the appearance required its differentiation from a mediastinal mass (Fig. 3). Debré and Mignon,<sup>3</sup> observing this appearance in children, called attention to the fact that it must not be wrongly considered an enlarged thymus. A very dense shadow of the vein in the paramediastinal position may be mistaken for calcification; likewise, in 2 cases (Fig. 2, 16, and Fig. 4) the appearance of the septum was that of a thickened strand in reinfection phase tuberculosis. Friedman<sup>4</sup> states that the azygos septum appears denser than the adjacent lung and must not be confused with thickened pleura. Stibbe<sup>12</sup> divided the position of the septum in 22 cases studied by dissection into: (a) more or less horizontal

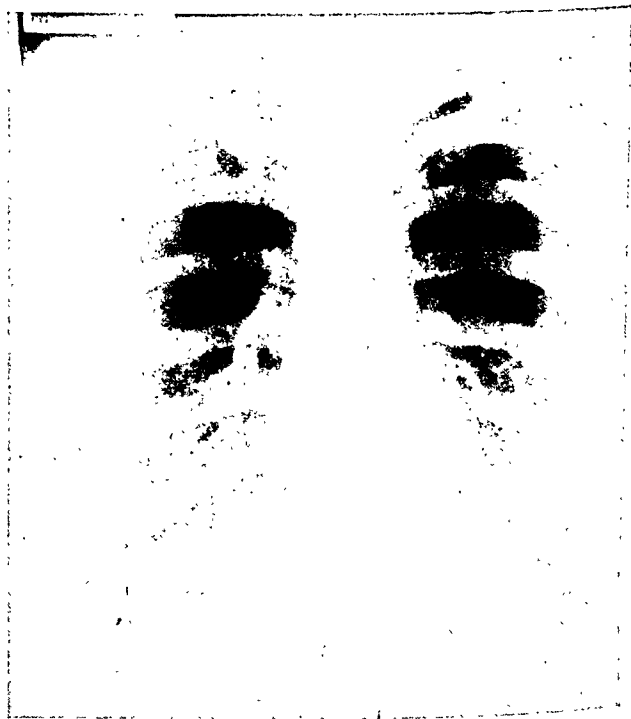


FIG. 4. Thickened azygos septum simulating strands of reinfection phase tuberculosis.

† From Armed Forces Induction Station, Altoona, Pa., 1943-1944.

cutting the lung at a point between the apex and 1 or 2 inches below it, (b) more nearly vertical thus dividing the apex into two more or less equal portions and (c) vertical, cutting off a small tongue-shaped lobe from the mediastinal surface of the upper lobe of the lung. The frequencies of these positions he found to be (a) 40.9 per cent, (b) 31.8 per cent, (c) 27.3 per cent. Most roentgenologists are accustomed to thinking of the typical mid-apical position with the dense tear-drop appearance of the vein at the base, and may miss a tenuous falciform shape such as shown in Figure 2, 3, 4, 5, considering it to be a fibrous strand.

The frequency of azygos lobes (septums) has been given as low as 0.07 per cent (6 in 8,000 examinations) by Litten<sup>9</sup> to as high as 0.82 per cent (8 in 887 examinations) by Lévy and Cade.<sup>8</sup> Minehart<sup>10</sup> reported 13 in 10,000, or 0.13 per cent. The incidence of this anomaly in the variety of positions described above was found in this series of 50,000 consecutive examinations to be 130 (0.26 per cent) or 1 in 384 chest examinations. From these figures it will be seen that the occurrence is fairly infrequent and one may go for some days in a busy hospital practice before discovering an aberrant azygos vein and septum.

#### SUMMARY

Attention has been drawn to the fact that an aberrant position of the azygos vein produces an anomaly of septation rather than of lobation of the lung. The azygos septum is composed of two layers each of parietal and visceral pleura, unlike the ordinary lung septum which is formed of two visceral layers. Also against its being a true lobe is the fact that it is not supplied by a primary branch from the right main bronchus but rather by a twig of the eparterial stem of the bronchus to the right upper lobe. Examples have been given of a wide variety in position and form

that the azygos septum may assume. Finally the incidence of azygos septation of 1 in 384 chests examined of a total of fifty thousand has been compared with the reports of others, none of which included more than ten thousand examinations, and likely represents a true index of the number to be encountered in routine studies.

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# ROENTGENOGRAPHIC VISUALIZATION OF THE PLACENTA IN THE THIRD STAGE OF LABOR

## A PRELIMINARY REPORT

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AUGUSTA, GEORGIA

IN RECENT years, the roentgenographic visualization of the placenta has received more and more attention as to its significance in the diagnosis and treatment of certain obstetrical difficulties. Several techniques have been developed for roentgenographic visualization of the placenta, some of which have been rather practical; although the chances for error in diagnosis remain great, even in the hands of the more experienced roentgenologists.

The significance of the position of the placenta in utero in certain pathological conditions is too well established to need elaboration at this time. However, many points relative to the placenta such as its relationship to the fetal position and its mechanism of detachment and expulsion from the uterus are not too well understood, and therefore need further study and clarification. A preliminary report on a technique for visualization of the placenta in utero following the second stage of labor is offered with the hope that it may aid in the study of placentation and in the search for the perfect technique of placental visualization. We believe that the technique described is immediately applicable in the diagnosis of placenta accreta.

Torpin<sup>11</sup> showed the placenta attached to the relatively flat anterior or posterior uterine wall, with a new method of studying placentation. He found that the placenta seldom extend over the dividing line between the anterior and posterior wall, either laterally or over the apex of the fundus.

Until 1930, very little was offered from the roentgenological standpoint to the field of obstetrics. In 1932, Ehrhardt<sup>4</sup> and Katsuya,<sup>5</sup> working independently, used tho-

rium dioxide in animals with a resulting visualization of the liver and spleen as well as the placenta. These workers advised against the use of thorium salts in humans. Lewisohn<sup>6</sup> used the same substance in humans and showed it to have an affinity for the reticulo-endothelial system. Stewart Einhorn and Illick<sup>10</sup> reported unfavorable reactions following the use of thorotrast (thorium dioxide). The work of these investigators has been borne out, and the use of thorium as a contrast medium in roentgenography is now strongly contraindicated due to its radioactivity, its affinity for the reticulo-endothelial system and the prolonged retention of the drug in the tissues.

Campbell, Miller, Menees and Holly<sup>2</sup> injected a water soluble contrast medium consisting of strontium iodide directly into the amniotic cavity of patients near term. Their procedure consisted in passing the needle through the abdominal wall and uterus into the amniotic cavity. The dye was then injected and roentgenograms taken. The placenta was visualized indirectly by the shadow made through the displacement of the surrounding opaque dye. They claim that reports of high death rates from this procedure were due to sodium iodide, and suggested the use of strongium iodide as a safe procedure. However, were the contrast medium safe, the dangers in amniography are still present; namely, perforation of viscera, trauma to the fetus, and early separation of the placenta due to hemorrhage.

In 1934, Ude, Weum and Urner<sup>12</sup> described their technique of indirect placentography. This consisted of studying the size, shape, and space between the pos-

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terior wall of the bladder, previously injected with a solution of sodium iodide and the lower margin of the presenting fetal head. Since the initial investigations of these workers, others have shown fairly good results with their technique. Even so, the procedure is not very satisfactory in other than vertex presentations.

From time to time various radiologists have reported visualization of the placenta on conventional roentgenograms. In 1940, Dippel and Brown<sup>3</sup> reviewed the subject of placental visualization by roentgenography and presented an excellent paper on their technique of direct visualization of the placenta by soft tissue roentgenography. They utilized factors for soft tissue technique and obtained very good results. Their work was confirmed by later workers including Baylin and Lambeth<sup>4</sup> and Smith<sup>9</sup> in 1943, and Scheetz, Good and Hunt<sup>8</sup> in 1945. These later workers added more information to the original work of Dippel and Brown, either by modifying their technique or combining the direct with the indirect method of visualization.

In 1941, Lloyd and Samuel<sup>7</sup> presented a series of 5 cases in which they were successful in demonstrating the placental site adequately by tomography. However, no further studies have been reported on their technique.

The ideal contrast medium for placental visualization would be one that could be administered either orally or parenterally which would have no deleterious effects on the fetus or the mother and cause neither premature labor nor toxic residual effects after the examination, yet give a satisfactory prepartum visualization of the placenta. The technique described here does not offer the ideal in placental visualization, but it does offer the possibility of assisting in the study of placentation.

Following delivery of the infant, there is a short period before the placenta is separated from the uterus. This period may vary normally from ten minutes to an hour; however, inasmuch as this time is not constant, the shorter period must be assumed for this technique. A sterile, water

soluble radiopaque dye (diodrast compound solution, 35 per cent weight volume Winthrop) is injected into the umbilical artery, after the fetus is delivered and the cord ligated. Films of the abdomen, anteroposterior view are made and a placentogram thus obtained.

*Technique.* Coordination between the obstetrical and radiological services is imperative since adequate time and forewarning is necessary in order to prepare for the examination. A urological table with a Potter-Bucky diaphragm is arranged as an obstetrical table in the delivery room. Portable roentgen-ray apparatus is used, the factors being 77.8 kv. (peak), 15 ma., 2 seconds and 30 inch target-film distance. (Since multiparas have a shorter and less predictable course of labor, a primipara of small dimensions was selected for our initial examination.) Observing the usual aseptic technique, a sterile syringe containing 20 cc. of diodrast solution is held in readiness for use by the obstetrician.

Following the delivery of the infant, the cord is cleansed with alcohol, the umbilical artery is identified and the needle of the syringe is inserted into it about 6 inches from the infant's umbilicus. A small amount of blood is withdrawn to confirm the location of the needle, the cord is then clamped and ligated and the infant taken over by an assistant. The dye is injected slowly with a moderate amount of pressure 20 cc. being given in about thirty seconds. As the dye is injected, the patient is brought into position, and approximately one minute after the delivery of the infant, a roentgenogram is taken. This is followed by roentgenograms at three and five minute intervals.

The placentogram (Fig. 1) taken one minute postpartum shows a fairly circular placental shadow lying en face with some evidence of concentration of the dye within the placental tissue. The placental shadow measures approximately 14 cm. in diameter and is surrounded by a less opaque shadow which outlines the uterus. The outer limits of the uterine shadow extend about 1.7 cm. from the margin of the



FIG. 1. Placentogram.

placenta. One-half of the placento-uterine shadow lies above the iliac crests and reaches the level of the second lumbar vertebra. The placental shadow is subdivided into areas corresponding to the cotyledons which are demonstrated in this view. The umbilical artery is seen filled with dye and its entire course is well visualized. It is seen to pass into the uterus, and at the placental junction, it divides into its many ramifications which are clearly visible.

The placenta was examined after its delivery and was found to appear normal and to conform to the roentgenological appearances demonstrated on the placentogram. The patient made an uneventful postpartum recovery, and suffered no toxic or after effects from this examination.

We wish to stress that this is a preliminary report on a technique for examination of the placenta in utero. Further studies and correlation with pathological changes will be necessary before we can consider this an acceptable technique for general use.

#### SUMMARY

A brief review of the literature of the

methods of roentgenological visualization of the placenta is presented. A new technique of placentography in the third stage of labor by use of diodrast injected into the umbilical artery is described. The roentgenological appearance of the placentogram obtained is presented. Subsequent studies with regard to pathology and improvement in technique are now being carried on.

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# EOSINOPHILIC GRANULOMA OF BONES ASSOCIATED WITH INVOLVEMENT OF THE LUNGS AND DIAPHRAGM

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INVESTIGATIONS of recent years have brought about new concepts of the Hand-Schüller-Christian disease and its relation to reticulosis or non-lipid histiocytosis, and to the more recently described bone lesions, to which the term eosinophilic granuloma is generally applied. Most writers agree that the basic disorder in these diseases is a peculiar inflammatory histiocytosis. Transitions from eosinophilic granuloma into Letterer-Siwe's disease, on the one hand, and of Letterer-Siwe's disease into the classical forms of Hand-Schüller-Christian's disease, on the other, have been observed. Reports of cases in which the Hand-Schüller-Christian disease is associated with osseous changes characteristic of eosinophilic granuloma are—as far as we were able to ascertain—limited to the cases of Thoma, and Versiani and his collaborators. It may therefore not be amiss to report a case which we recently had the opportunity to observe. The findings in this case may be helpful in establishing the interrelation between eosinophilic granuloma and Hand-Schüller-Christian's disease on a firmer basis.

## CASE REPORT

This patient, aged nineteen, entered an Army hospital in the fall of 1946 complaining of severe pain in the low back, radiating into both lower extremities, polydipsia, and polyuria. The patient was unable to stand or walk; he could move his legs in bed only slightly because of marked weakness.

The family history was not contributory. In childhood the patient had measles, mumps, chickenpox and whooping cough. He had always been rather sick and never felt very well. He has been suffering from backache since early childhood. This confined him to bed on numerous occasions, and necessitated the use of me-

chanical back supports. Even minor injuries incapacitated the patient over periods of months, and they were usually followed by pain radiating downward, along the distribution of the sciatic nerves, and by marked muscular weakness of the extremities. A roentgen examination in October, 1945, revealed destructive lesions in the lumbar spine, both iliac wings of the pelvis, and the femoral necks. These lesions were thought to represent multiple hemangiomas and were treated by irradiation. Following roentgen therapy, the patient's symptoms improved slightly. Shortly after induction into the service, in April, 1946, he noticed that he was drinking large quantities of water; the diuresis increased correspondingly, causing also frequent nocturia. The backache became much more severe, and the muscular weakness of the lower extremities made it impossible for the patient to stand or walk. He was admitted to the hospital, when one day he suddenly lost control of the lower extremities completely, and fell. In addition to these symptoms, there was also a slight hacking cough, which was apparently of a chronic nature. The patient lost approximately 15 pounds in weight in the last three months.

The patient was admitted to this hospital in October, 1946, and essentially the same clinical history was obtained.

*Physical Examination.* The patient was a well developed, well nourished young white male. The temperature was 98.6° F., pulse 90, respiration 24. Blood pressure 122/78. The positive findings elicited were: (1) fine moist rales at the base of the left lung posteriorly, (2) mild pain on deep pressure of all long bones of the body. Severe pain was elicited on pressure over the lower lumbar spine. Superficial and deep reflexes were normal but the patient could not move his legs fully even while lying in bed. The leg muscles were not atrophic, but rather flabby in character. (3) The foot muscles showed some atrophy, so that a pes cavus was present. (4) The finger nails were rather brittle.

*Laboratory Findings.* The urine showed a low



FIG. 1. Several calvarial defects in the parietal bones.

specific gravity varying between 1.004 and 1.006 on repeated examinations. The daily water intake and output measured from 3,500 to 8,000 cc., with an average during present hospitalization of approximately 5,000 cc. Two urine concentration tests showed a good con-

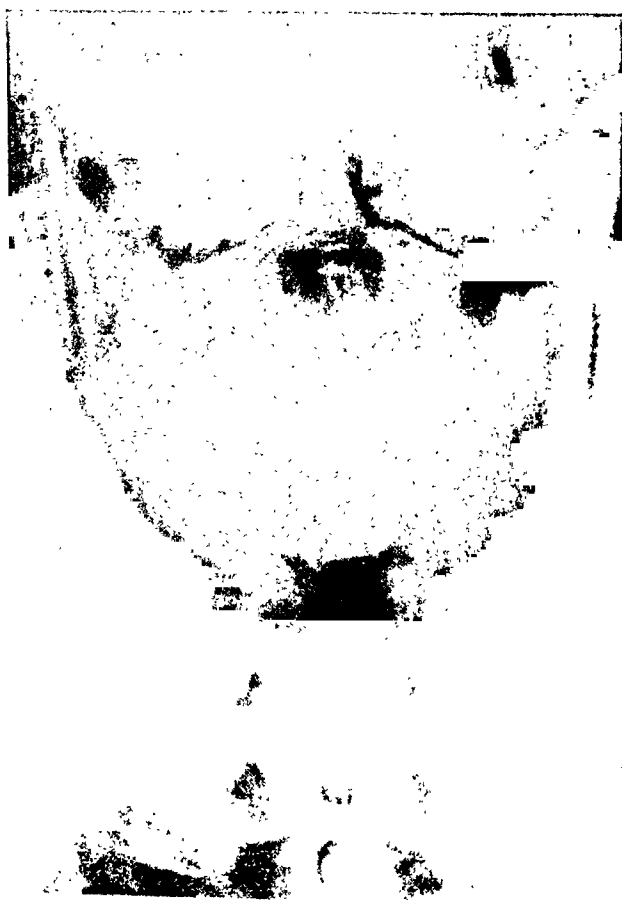


FIG. 2. Large central bone destruction of the second cervical vertebra.

centration, evidenced by a fall in diuresis to 2,000 cc., and an increased specific gravity up to 1,024. The urine contained increased amounts of calcium; a quantitative test revealed 500 mg. of calcium in 5,000 cc. of urine excreted during twenty-four hours. The erythrocyte and leukocyte counts were normal; there was a slight eosinophilia (10 per cent). The blood calcium level was 10.3–12.0 mg. per 100 cc. The blood phosphorus was 4.4–5.8 mg. per 100 cc. The alkaline phosphatase showed 3.4 Bodansky units on one determination, and 6.9 Bodansky units on another examination. The acid phos-



FIG. 3. Central defect in the fibula.

phatase was 0.2 King-Armstrong unit. The total protein was 7.2 gm. per 100 cc., with an AG ratio 4.6/2.6. The blood cholesterol level was 185 mg. Corrected sedimentation rate was 10 mm. per one hour. Kahn test was negative.

Roentgen examination of the skeleton showed several round areas of decreased density within both parietal bones, surrounded by a narrow sclerotic zone; the largest lesion measured approximately 1.5 cm. in diameter. There was a large area of bone destruction within the body of the second cervical vertebra. The ninth to eleventh right, and eighth and ninth left ribs showed oblong areas of rarefaction, which failed to produce pathological fractures, bone expansion, or periosteal reaction. The eleventh

and twelfth dorsal and all lumbar vertebrae were markedly altered. Normal trabecular bone architecture was replaced by "cystic" areas of rarefaction, involving the vertebral bodies and their processes. There was some lateral wedging of the vertebral bodies, whose articular surfaces were distinctly concave. Several "cystic" areas of rarefaction were observed in both iliac wings and both pubic bones. The long bones of the extremities were also involved. There were several small areas of rarefaction and one larger measuring 3 by 1.5 cm. within the medullary portion of the shaft of the right humerus. The endosteal surface of the cortex at the site of the larger lesion was eroded. Similar lesions were observed within both femoral necks, both distal femoral metaphyses and in the shaft of the left tibia and fibula. No expansion of bone or periosteal reaction was observed.

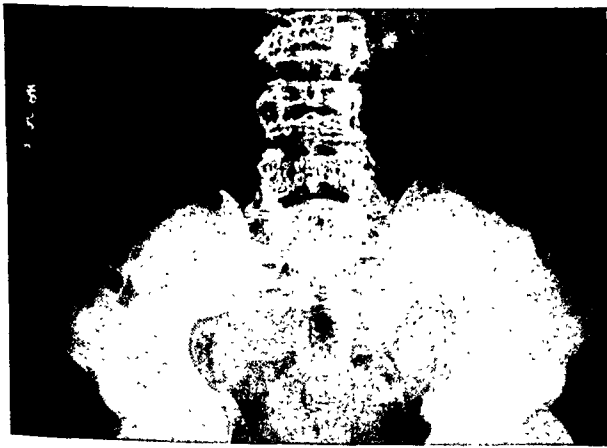


FIG. 4. "Cyst"-like rarefactions in the vertebrae and iliac wings.

An examination of the chest showed a moderate fibrosis of the dorsal segment of the left lower lobe, and a homogeneous density in the right lower lung field, obliterating the cardio-phrenic sinus, and inseparable from the diaphragm. The oblique superior margin of this density was sharply defined. A combined diagnostic pneumothorax and pneumoperitoneum were performed. A good collapse of the right lung was obtained. Both diaphragmatic leaves were well outlined and the abdominal organs visualized. There was no evidence of atelectasis. The right diaphragm was approximately 2 cm. thick. The ventrodorsal films revealed a polycyclic soft tissue mass inseparable from the anteromedial portion of the diaphragm, extending slightly below the inferior margin of the diaphragm. In a lateral projection an oval

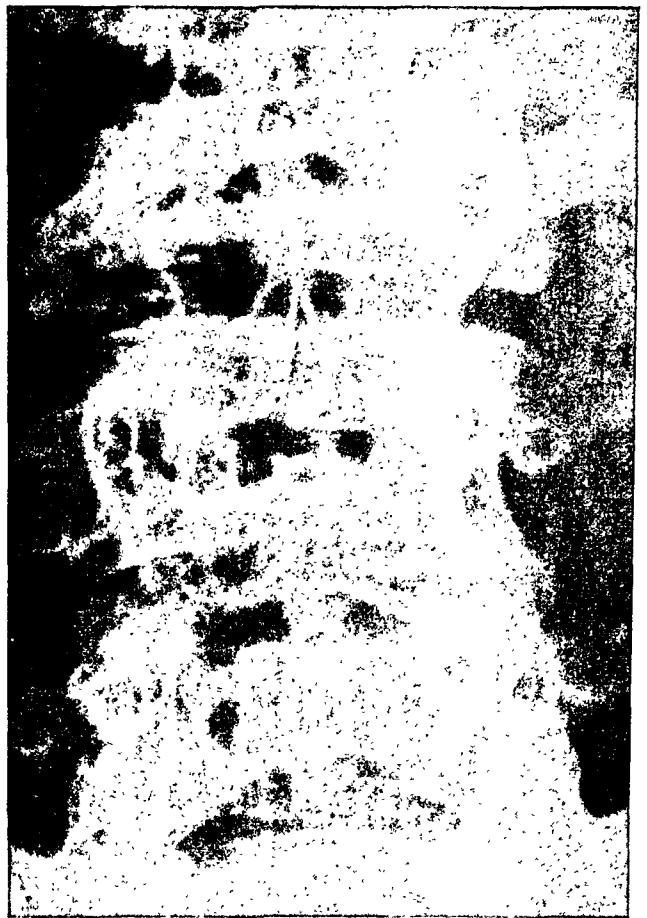


FIG. 5. Close up view of the third to the fifth lumbar vertebrae shows the significant bone changes.

shadow was demonstrated, obliterating the anterior sinus, and resting firmly on the diaphragm, from which it could not be separated. These findings were interpreted as consistent with involvement of the diaphragm, with extension of the mass into the anterior mediastinal space.



FIG. 6. Destructive lesions in the right pubic bone and the femoral neck.





FIG. 7. Destructive lesions in the left pubic bone and left femoral neck.

A section from an involved rib was obtained for biopsy. According to the description of the gross specimen, the cortex in the inferior costal groove contained a defect entering into the medullary cavity 13 by 3 mm. in size. The cortex was 1 mm. thick. Coarse bone traversed the medullary cavity, which was soft and reddish brown in color. The microscopic examina-



FIG. 8. Homogeneous density obliterating the right cardiophrenic sinus. Fibrosis of the left lower lobe.

tion revealed sections of compact and cancellous bone. A few small fragments of soft tissue were present bearing the appearance of marrow. The fat cells were crowded out by a large number of eosinophils and a few macrophages showing some evidence of phagocytosis. Pathological diagnosis: Eosinophilic granuloma.

#### DISCUSSION

Rowland defined Schüller-Christian's disease as a xanthomatous degeneration of the skeleton, characterized by proliferation



FIG. 9. Lateral view of the chest. The opacity on the right lies anterior to the mid-axillary line, and is inseparable from the diaphragm.

of fibrous tissue containing nests of xanthoma or foam cells, studded with birefringent esters of cholesterol. Many writers supported this view, which is still held by Thannhauser. This author classified Schüller-Christian's disease under "primary essential xanthomatosis of the normocholesteremic type." In this peculiar systemic disorder, foam cells develop singly or in large nests, despite the fact that the cho-

lesterol level of the circulating blood is normal. The reticulum cells and histiocytes retain normally the functional possibilities of embryonal cells, capable of forming various kinds of lipids and also of cholesterol. A disturbance of the intracellular enzymatic systems concerned with the formation of cholesterol may result in an accumulation of cholesterol within the cell, thus transforming it into a xanthoma cell.

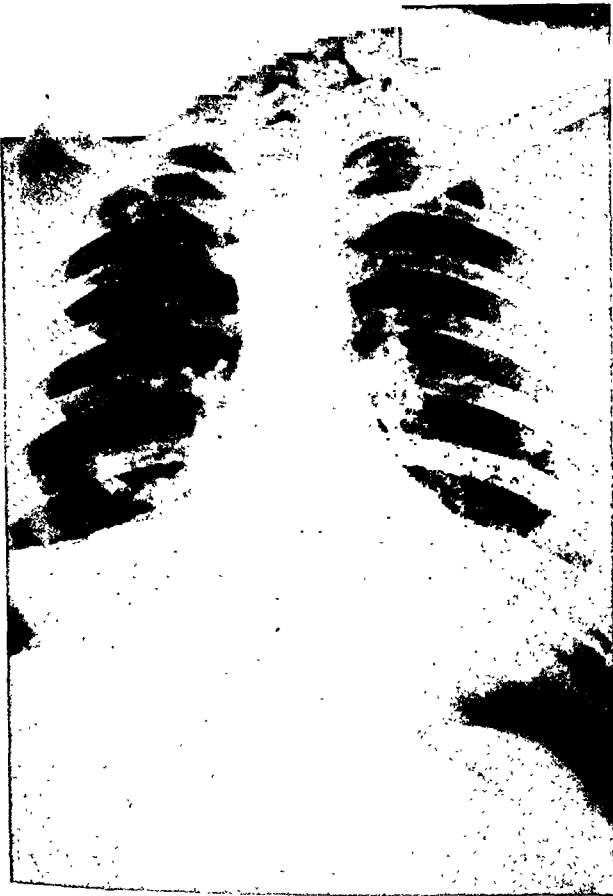


FIG. 10. Combined pneumothorax and pneumoperitoneum. The intrathoracic opacity is not due to atelectasis. The right diaphragm is much thicker than the left.

Not denying that granulomatous tissue is present to a greater or lesser degree in every xanthomatous lesion, Thannhauser found no justification in classification of the disease as "lipid granulomatosis." The inflammatory origin was suggested by Chester, who pointed out that proliferation of the reticulo-endothelial cells and histiocytes constitutes the chief pathologic alterations.

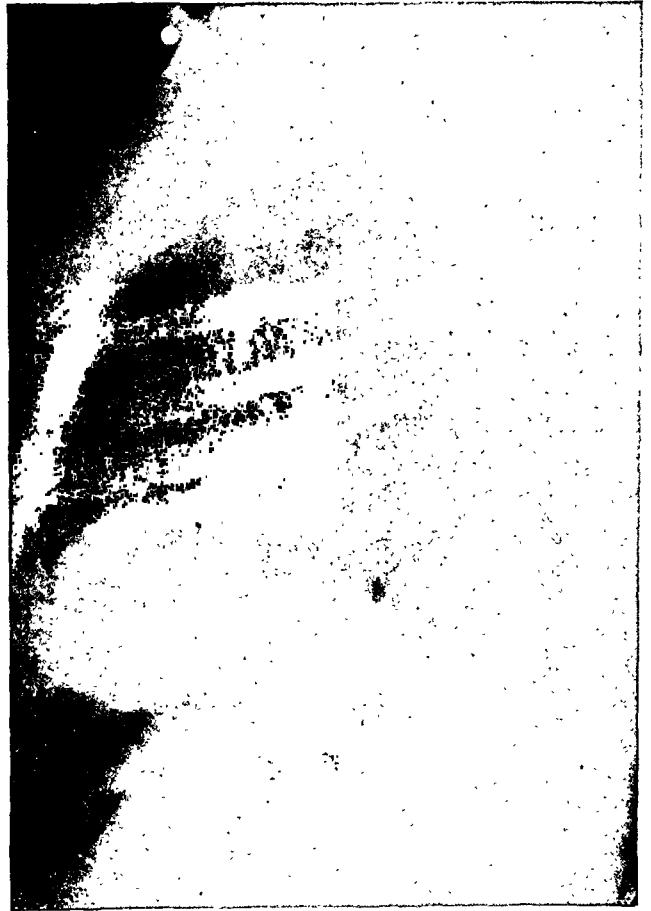


FIG. 11. Lateral view, demonstrating the circular opacities in the anterior sinus; they are intimately connected with the diaphragm and project below the inferior margin of the diaphragm.

Chester's observations have been confirmed by Letterer, Siwe, Wallgren, Farber, and others, who include aleukemic reticulosis, diffuse reticulo-endotheliosis and non-



FIG. 12. The liver is clearly separated from the diaphragm; the "tumors" at the right base are clearly demonstrated.

lipid histiocytosis in the same fundamental pathologic process. The variations in the clinical behavior and histopathologic appearance of the lesions, are, in Farber's opinion, due to the degree, stage of involvement, and localization of the same basic disorder, which, however, does not suggest a primary alteration of lipid metabolism.

Eosinophilic granuloma described independently by Otani and Ehrlich, and by Lichtenstein, and Jaffe, represents the latest number of this group. The close interrelations between this lesion and Letterer-Siwe's disease, and Schüller-Christian's disease were particularly emphasized by Farber and Green, and their views have been accepted by Mallory, Lichtenstein and Jaffe, and others. Mallory believes that the variations in clinical manifestations of the disease depend on the chronicity of the basic pathologic process. In infancy and early childhood, the clinical course is often acute, and the disease terminates fatally (Letterer-Siwe). The histiocytic lesions are widely disseminated in the soft tissues and the skeleton. In a chronic form (Schüller-Christian), observed in children or adults, the lesions may become collagenized, and lipidized. In addition to the skeletal manifestations, the disease affects not infrequently the pituitary gland, the brain, the lungs, and the heart. Eosinophilic granuloma, solitary or multiple, represents the mildest form of the disorder, and is confined solely to the skeletal system. This lesion responds well to surgical treatment or irradiation, and may heal occasionally by spontaneous resolution.

Insufficient evidence is available in the literature to prove that Hand-Schüller-Christian's disease can be associated with skeletal changes seen only in eosinophilic granuloma. Though it has been demonstrated that collagenization and lipidization in lipogranulomatous lesions have been engrafted on lesions which originally were dominated by histiocytes, still free of lipid, all 3 cases studied by Lichtenstein and Jaffe were in the lipogranulomatous stage at the time of examination. These authors,

therefore, postulated that only those cases should be included in the group of Schüller-Christian's disease, which show, as the anatomic prerequisite, lesions classifiable as lipogranuloma. They did not deny, however, that it was logically probable that the bone lesions in Schüller-Christian's disease may originally resemble those of eosinophilic granuloma. The cases reported by Versiani and his collaborators, and by Thoma, in which eosinophilic granuloma of bone was associated with diabetes insipidus, may well present evidence to support this view, and perhaps make the rigid criteria proposed by Lichtenstein and Jaffe untenable. Our own case is an example, thus far, of rare association of eosinophilic granuloma with intrathoracic alterations. The evidence presented by these cases seems to be reasonable, since it is the association of Schüller-Christian's disease with this type of bone lesion which is in question. Apparently, the discrepancy between the histopathological appearance of osseous and visceral lesions has not been considered of paramount significance. It does seem worthy of emphasis that there are no reports of visceral lesions dominated by eosinophiles equivalent to those seen in the bones. It is interesting to note that the clinical history in our patient is of long duration, and the bone lesions are most likely of considerable standing. The prevalence of eosinophils in a bone lesion examined histopathologically does not appear to lend support to the opinions expressed by some authors, that only early lesions exhibit histopathologic features of eosinophilic granuloma and that the subsequent changes occur fairly rapidly. One may well raise the question whether or not there are considerable differences in the evolution of the basic pathologic process. It seems possible that the process can be arrested in a certain phase of evolution for a variable length of time and even become limited to it. In other cases, the eosinophils may appear only few in number and the histiocytes may represent the dominant cells. They, too, may exhibit variations in degree and rate of subsequent lipidization.

The clinical course and objective findings exhibited by our patient do not justify inclusion of this case in the category of Letterer-Siwe's disease. The significant alterations affect the bones and the lungs. There is no demonstrable evidence of involvement of other organs seen in Letterer-Siwe's disease. A new, not previously reported, finding is the tumor of the diaphragm. This lesion was detected only after a combined pneumothorax and pneumoperitoneum had been performed. Prior to that, the paracardiac density in the right lower lung field was interpreted as an atelectasis of the lower lobe. The assumption that the diaphragm is affected by the same disease appears to be justified by the fact that muscle (heart) has been involved in other instances of the disease.

The classical craniohypophyseal manifestations of Hand-Schüller-Christian's disease are not always present. The exophthalmus is apparently caused by retro-orbital proliferation of the granulomatous tissue. Diabetes insipidus could well be precipitated by involvement of the brain, dura, or both in the region of the hypophysis or the thalamus. Cases in which diabetes insipidus was observed without demonstrable calvarial defects militate against the opinion of Lichtenstein and Jaffe, that the presence of the craniohypophyseal manifestations depend solely on extensive involvement of the bones of the skull.

The literature on histiocytosis is expanding rapidly and the clinical and pathological observations thus recorded provide increasing evidence of the close relations between the variants of the disease. Association of Hand-Schüller-Christian's disease with osseous lesions identified as eosinophilic granuloma appears to have been demonstrated in at least several instances, including also the case presented here. The hypophyseal manifestations of the Schüller-Christian triad can apparently occur without extensive skeletal involvement of the skull. Involvement of the diaphragm has not, as far as we know, been reported in the past, but obviously represents another site of muscular involvement.

Many aspects of this general disorder remain vague, and need further clarification. It does not appear clear to us why an inflammatory process in its most florid form occurs only in young children. We do not understand why the visceral lesions of this disorder fail to exhibit histopathological changes equivalent to "eosinophilic granuloma" of bone, although the discrepancy between the histopathological characteristics of the visceral and osseous lesions does not seem to be significant to the pathologists. We are not certain that the "eosinophilic" phase of the bone lesions is significantly related to the age of these lesions. Certainly the fact that the other phases have been observed more frequently does not preclude the possibility that the eosinophilic phase may persist longer than several weeks or months. The history in our case points to a long duration of the bony changes, which were definitely demonstrated over one year ago.

It does seem possible that there are significant variations in the evolution of the basic pathologic process, and that the clinical manifestations of the disease in its chronic forms depend largely on the localization of the lesions. We also doubt that the acuteness of the disease in a given case can be determined from the histopathological appearance of any single lesion. The prognosis depends most likely on the clinical course of the disease.

Granting that the evolutionary variations of the anatomic life cycle of the disease are inferred, it may be rightly pointed out that the pathological concept of the disease has undergone considerable modification since the appearance of the first reports on eosinophilic granuloma alone. Further observations may prove the present definition of the disease not less inadequate.

#### CONCLUSIONS

1. A case of multiple bone lesions, associated with involvement of the lungs and diaphragm, is presented.
2. Histopathological study of an affected rib revealed changes characteristic of an eosinophilic granuloma.

3. The histopathological evidence tends to confirm the current views that there is a close relation between eosinophilic granuloma and Hand-Schüller-Christian's disease. The postulation that only cases with lesions classifiable as lipogranuloma to be included in the group of Hand-Schüller-Christian's disease appears too rigid. This case demonstrated the association of eosinophilic granuloma with pulmonary and diaphragmatic involvement, whereas the cases reported by Versiani and his collaborators and Thoma emphasized the co-existence of eosinophilic granuloma and the craniohypophyseal manifestations of the disease.

4. It is worthy of further study to observe whether or not the eosinophilic granuloma is only an early manifestation of the basic disorder and is soon replaced by other elements of the evolutionary cycle. It may well be that the histological characteristics of the lesions are retained for considerably longer periods of time than heretofore assumed.

5. It does not seem warranted to assume from an examination of one bone lesion that all other lesions present the same histopathological structure.

6. The involvement of the diaphragm is apparently an observation not recorded in the literature previously. It obviously represents another example of a muscular organ which can be involved in this disease.

7. The method of combined diagnostic pneumothorax and pneumoperitoneum again proved of definite value in establishing the anatomical relations of homogeneous densities, inseparable from the diaphragm.

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# RADIOACTIVE SODIUM AS A TOOL IN MEDICAL RESEARCH\*

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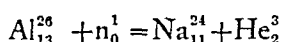
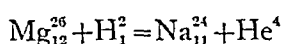
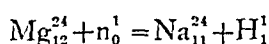
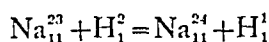
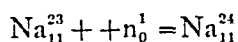
THE production of radioactive sodium was announced in 1934, as the result of bombarding sodium with neutrons, by Fermi and his collaborators, and later by the Curie-Joliot.<sup>1,2</sup> In the same year, Lawrence produced it by deuteron bombardment in the cyclotron.<sup>3</sup> It was the first artificially radioactive substance found which had a half life of more than a few minutes; its half period of about fifteen hours, and the fact that it emitted penetrating beta and gamma rays led to some over-enthusiastic prophecies that it would soon displace radium in medicine. This has not been the case, but it has been found very useful in its own right.

Radioactive sodium can be produced in five different ways, by bombarding sodium with neutrons or deuterons, magnesium with neutrons or deuterons, or aluminum with neutrons. In every case the product is the same, a sodium nucleus containing an extra neutron and therefore having atomic weight 24 instead of 23. The various reactions are shown in Table I. In every case the radioactive atoms disintegrate by the same stages—ejection of a beta ray, transforming the nucleus to magnesium, and emission of gamma rays as the magnesium becomes stabilized (Fig. 1). This disintegration proceeds at such a rate that half the radioactive atoms are destroyed in 14.8 hours, half the remainder in a like period, and so on.

In practice, most of the radioactive sodium used up to the present time has been made in cyclotrons, by deuteron bombardment; now it is also to be made available from the uranium "pile" at Oak Ridge. The sodium in the bombarded target may be in the metallic state or may be a salt. In either case, after removal from the

cyclotron or pile, the sodium is chemically separated from other substances, if necessary, and is usually delivered for use in the form of a solution of sodium chloride. In this solution only an extremely small fraction of the sodium atoms are radioactive; the remainder is in the ordinary stable form.

TABLE I



In living animals, sodium is uniformly distributed throughout extracellular body fluids, the sodium ion passing freely back and forth across capillary membrane. When radioactive sodium is administered by mouth or intravenously, it rapidly appears throughout the body. Since it emits penetrating radiation, its presence in a part of the body can be demonstrated by bringing near it a sensitive detector of radiation. The instrument usually employed is a Geiger-Müller counter, which can detect the ionization due to a single atomic disintegration. Counting tubes can be of different sizes, and shielded to admit radiation from only a definite region. Figure 2 shows some which have been useful in work with radioactive sodium.

Soon after the discovery of radiosodium, experiments were made to see how promptly the material, orally or intravenously administered, could be demonstrated in an extremity.<sup>4</sup> Studies of rate of excretion and

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

deposition in various organs and tissues followed.<sup>5</sup> These may be characterized as typical tracer studies, rather than as uses of radioactive sodium as a tool.

One of the first applications which might be characterized in this manner was the work of Kaltreiter and his associates at the University of Rochester in the determination of the volume of the extracellular fluid of the body.<sup>6</sup> Previous measurements of this sort had been done with sucrose, sul-

gans, and therefore the volume determined by this substance includes some intracellular fluid. Sodium is excreted very slowly and it does not enter blood or tissue cells appreciably, but it does slowly enter bone. However, determinations made with it within three to six hours after administration should be quite satisfactory. The use of radiosodium has the advantage of ease and simplicity, if the material and Geiger counter are available. Kaltreiter and his

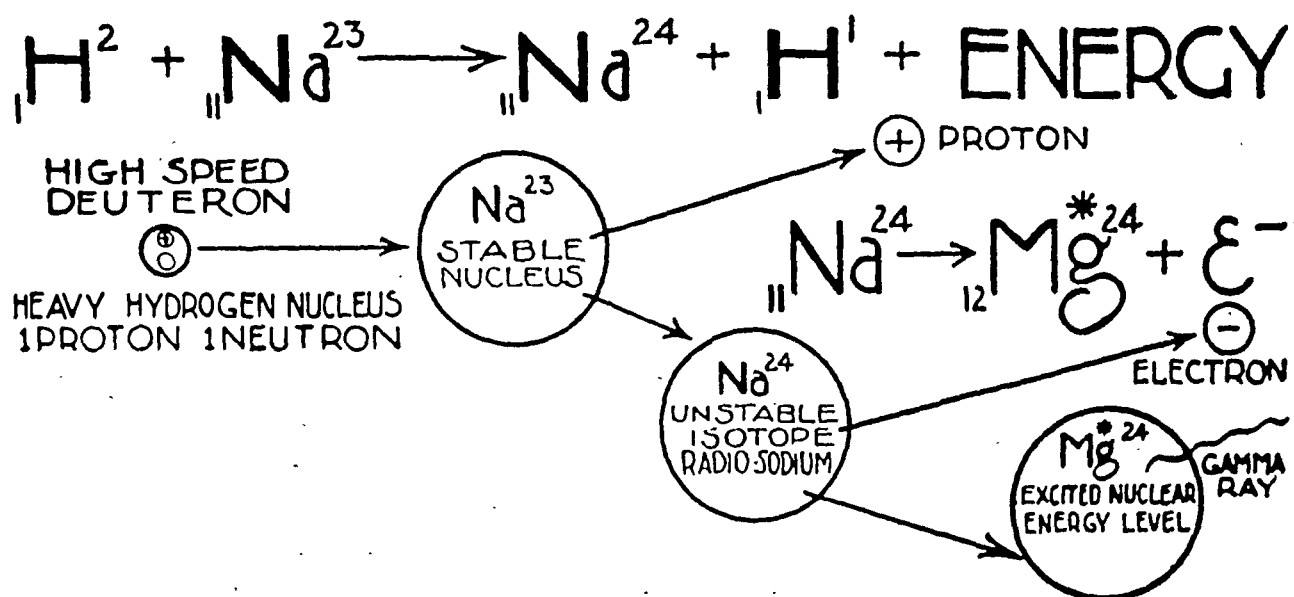


FIG. 1. Diagram of production and disintegration of radioactive sodium.

fate, and thiocyanate, but all of these have definite drawbacks. The principle is simple. Some hours after the intravenous administration of the test chemical, a sample of blood plasma is obtained and the concentration of the substance measured in it. Up to this time, all material excreted has been saved, and the amount of the test substance lost in this manner determined. Assuming that the material is uniformly distributed in extracellular fluid, the amount remaining in the body (the amount administered minus the amount excreted) divided by the amount per unit volume in the serum, gives the volume of fluid in which it is dissolved. Sucrose and sulfate are not very satisfactory because of the speed of their excretion. Thiocyanate is slowly excreted, but it enters the red blood cells and the cells of certain glandular or-

group, and others, have made series of measurements in both normal and diseased subjects, using radioactive sodium and thiocyanate simultaneously. Results obtained with sodium, corrected for absorption in bone, give about 21 per cent of body weight as "sodium space" extracellular fluid, of which 15 per cent is plasma and 85 per cent interstitial fluid. Corrected results with thiocyanate give a "thiocyanate space" representing 23.5 per cent of body weight. Repeated determinations on the same individual check well, provided general health is maintained. In patients with a disease producing serous effusion, concentration of radiosodium in pleural and ascitic fluid is essentially the same as in blood serum. In such patients the volume of extra fluid would be included in the extracellular volume determined by the use of

radioactive sodium, and hence an estimate of the volume of excess fluid could be made by comparing the result with the normal for an individual of essentially the same weight. Especially advantageous in such a problem would be repeated measurements in the same subject.

Leading directly from this work is the study of Fox and Keston at Columbia University on the mechanism of shock from

sodium is infiltrating into tissues where it does not normally go. In animal experiments, where shock was produced by a standard procedure, and analyses made with radiosodium, it was found that the burned tissues (skin and muscle, which normally contain very little sodium) did indeed take up a large proportion of the administered isotope. The consequence of this concentration in the damaged region

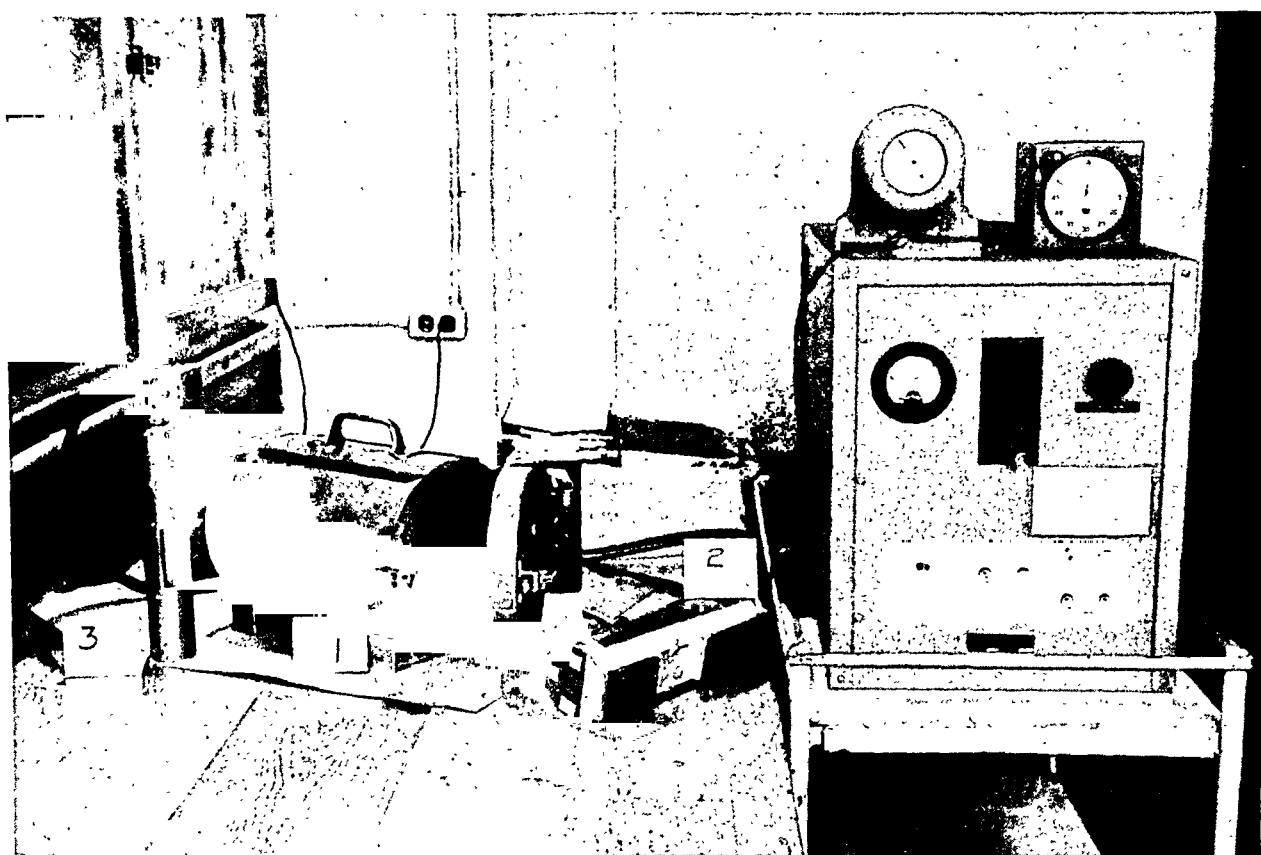


FIG. 2. Geiger Counter: scaling circuit and counting tubes.

burns and trauma, as traced by radioactive sodium.<sup>7</sup> Various clinical studies had indicated that in shock caused by extensive burns a redistribution of sodium and potassium took place. It appeared that the "anti-sodium barrier" between extracellular and intracellular fluids might have broken down. This could be tested with radioactive sodium by determining "sodium space" as just described. If this space is very much larger than normal, and there has been no commensurate increase in body fluid, as indicated by edema, it is evidence that the

would be a depletion of this electrolyte from normal parts of the body. If this is true, administration of an excess of isotonic sodium salt to the animal in shock should be remedial, and this in fact was the case. Burned animals treated by intraperitoneal injection of normal saline equal to 16 per cent of their body weight recovered, while similarly burned ones left untreated invariably died. In humans with severe burns the increase in "sodium space" together with the disappearance of sodium from the urine, indicated that the sodium



was being withdrawn from normal equilibrium in extracellular fluid. In one case it was possible to demonstrate with a Geiger counter that the radioactive sodium deposited within a burned region was considerably greater than in the corresponding part of the uninjured limb.<sup>8</sup> Successful treatment in this case and in similar ones was carried out by the administration of large volumes of isotonic (sixth molar)

A somewhat similar study is one concerned with mode and rate of formation of cerebrospinal fluid, by Greenberg and his associates at the University of California Medical School.<sup>9</sup> The key to the problem has been stated to be the role played by the tissue membranes separating the blood plasma and cerebrospinal fluid, in the distribution of ions and molecules between these two fluids. Questions are whether

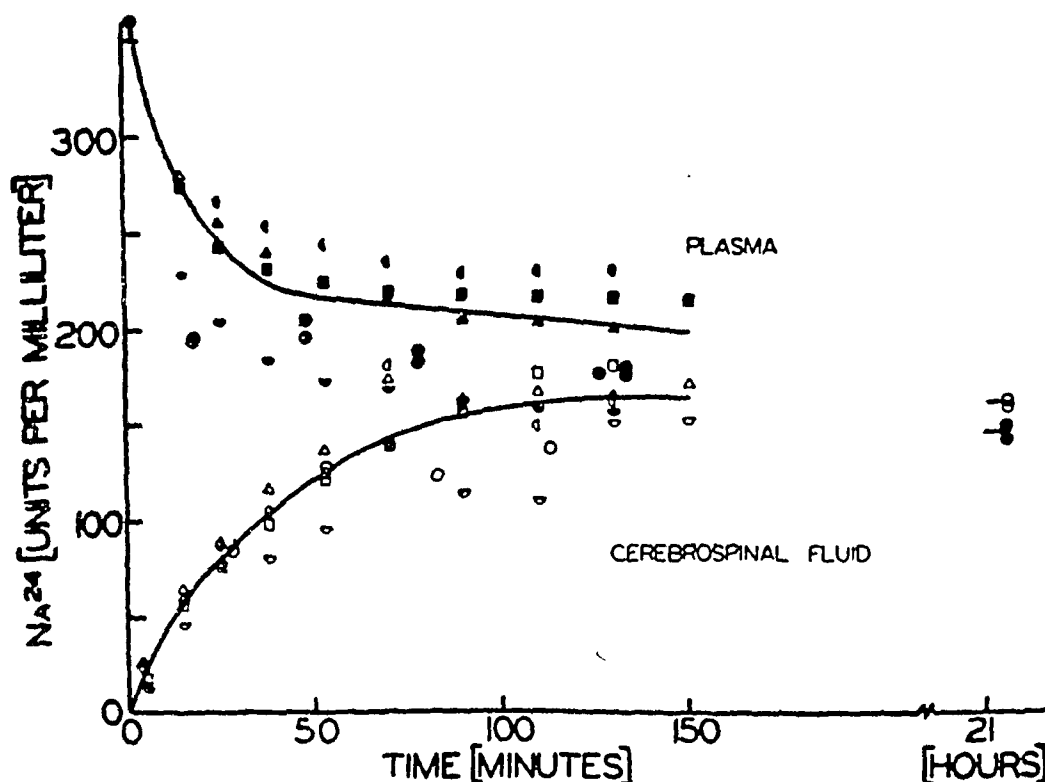


FIG. 3. Curves showing rate of disappearance of radioactive sodium from blood plasma and of its appearance in freshly formed cerebrospinal fluid in normal untreated dogs. Each experiment on an animal is represented by a characteristic symbol which is solid for plasma values and open for spinal fluid. Note change in time scale (indicated by break in abscissa) and fact that ultimately concentration is greater in spinal fluid than in plasma. (Courtesy of Dr. David M. Greenberg.)

sodium lactate solution by mouth or infusion. It appears that replacing the withdrawn sodium together with extra water aids in re-establishing fluid balances, maintaining blood volume and blood pressure, and thus combatting shock. In a preliminary series of cases, results by this type of treatment were as satisfactory as with intravenous plasma, and of course the procedures are much simpler. A more complete report on a larger series of cases is promised but has not yet appeared.

elements of the barrier membrane perform an active secretory function, whether the distribution of substances between the fluid and plasma is controlled only by passive diffusion, or whether these substances pass from plasma into extracellular fluid of brain and spinal cord and from these into spinal fluid. In the last case equilibrium would not be between plasma and spinal fluid, but between the latter and the extracellular fluid of the central nervous system.

The study was undertaken by injecting various radioactive substances intravenously and determining their rate of appearance in the spinal fluid. Large dogs were used as subjects; after sodium pentobarbital anesthetization a cisternal puncture was done and all pre-formed cerebrospinal fluid withdrawn. Continuous drainage was maintained to collect the newly formed fluid. The radioactive material was then injected and its rate of appearance in the newly formed fluid obtained. Radioactive sodium attains equilibrium in extravascular fluid in these dogs in about an hour. It begins to appear in the spinal fluid within a few minutes but does not reach plasma level for many hours. After twenty-one hours it is about 10 per cent higher in spinal fluid than in plasma, as would be expected on the basis of their respective chemical compositions. Sodium curves of these authors are shown in Figure 3; similar curves were obtained for other radio-isotopes, but the rates were different. Some elements showed a maximum in the cerebrospinal fluid, others did not. For all elements used, the ratio of concentration in spinal fluid to that in plasma took many hours to reach the values found in the stable state by chemical analysis. The delay was selective and varied greatly for different ions. The authors conclude that the hindrance to the free passage of ions from the blood stream to the extracellular fluid of the central nervous system, and the deviation from the Donnan law of distribution of the steady ratios of the concentrations of these ions between the spinal fluid and the plasma, constitute evidence that the exchange between the blood and the brain takes place by a process of secretion and not by simple diffusion or ultrafiltration.

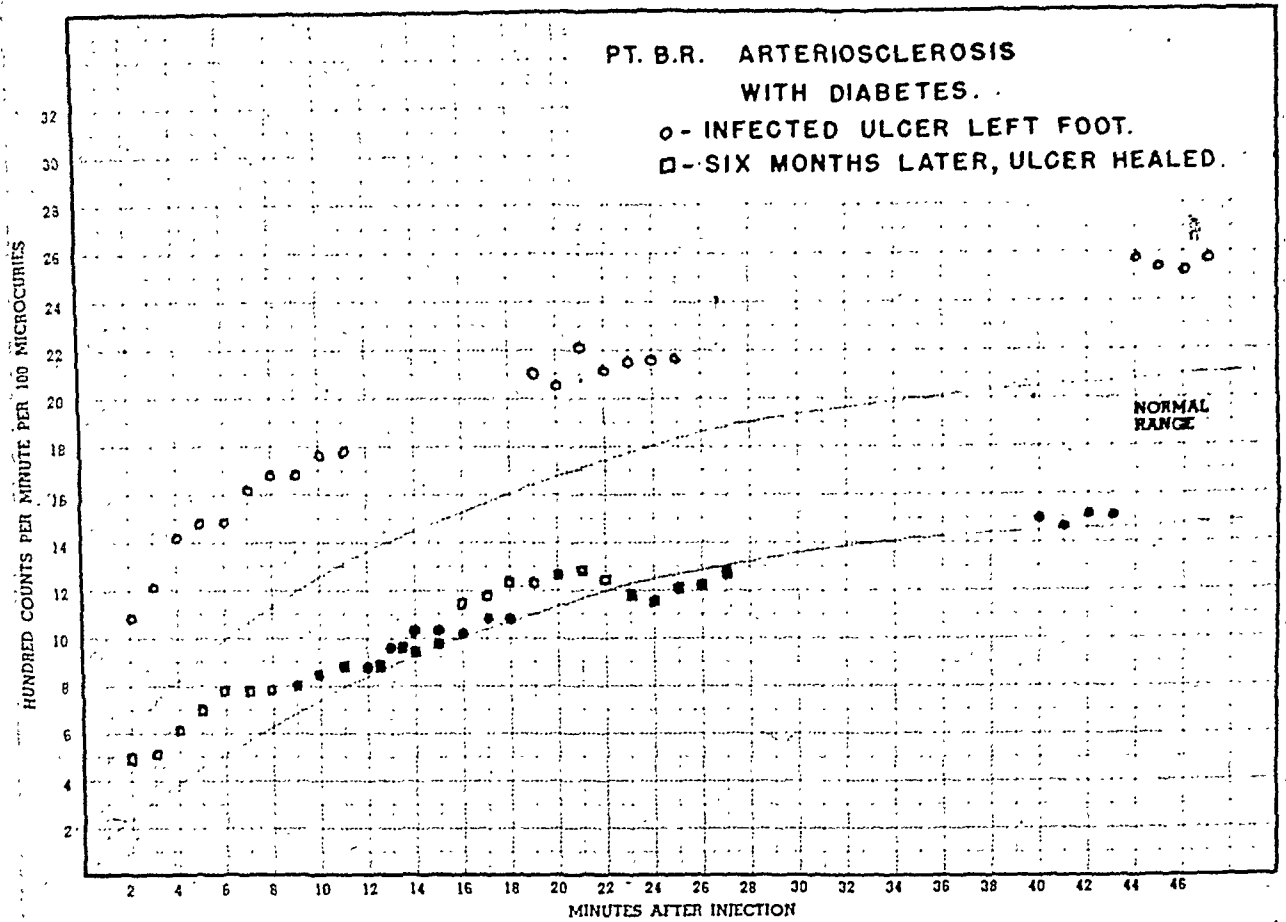
Experiments of the same general type were carried out by Visscher and his co-workers at the University of Minnesota to investigate movement of water and ions between intestinal lumen and blood,<sup>10</sup> and by others to study transfer of ions across membranes in different body regions.

Radioactive sodium was used by Hubbard, Preston, and Ross to determine the velocity of blood flow in infants and young children. The material was injected into one antecubital vein and the time of its arrival at the opposite hand determined by a Geiger counter.<sup>11</sup> Their series was small and the results quite variable, but were at least as satisfactory as those obtained by other methods.

This use of the material would readily suggest itself to anyone concerned with circulation times, and similar studies were initiated independently by Smith and Quimby in connection with work on patients suffering from peripheral vascular disease.<sup>12</sup> The material was injected into an antecubital vein, with the window of the portable shielded Geiger counter (2, Fig. 2) against the sole of the foot, and arm-to-foot circulation times measured. After a small group had been tested, it seemed that no valuable correlations between clinical condition and circulation time would be established. However, the work led to the development of a test which has proved very useful.

As equilibrium of radiosodium concentration is built up between plasma and extracellular fluid, the counting rate of the Geiger counter at the foot increases, because the blood continues to bring sodium to the capillaries, where some of it diffuses out into the interstitial fluid and remains there. A curve can be plotted showing increase in counting rate with time after administration of the material, and it has been found that the shape of this curve can often be correlated with clinical condition. In individuals with no known vascular disturbance the "build-up curves," calculated on the basis of 100 microcuries of radiosodium administered, all fall within the relatively narrow region indicated in Figure 4 as "Normal Range." For patients with various vascular disorders, the curves may be within, above, or below this region. A very low curve may be due to arterial obstruction, arteriosclerosis, hypertension, spasm, degeneration of capillaries, or com-

# RADIOACTIVE SODIUM CIRCULATION TEST



# RADIOACTIVE SODIUM CIRCULATION TEST

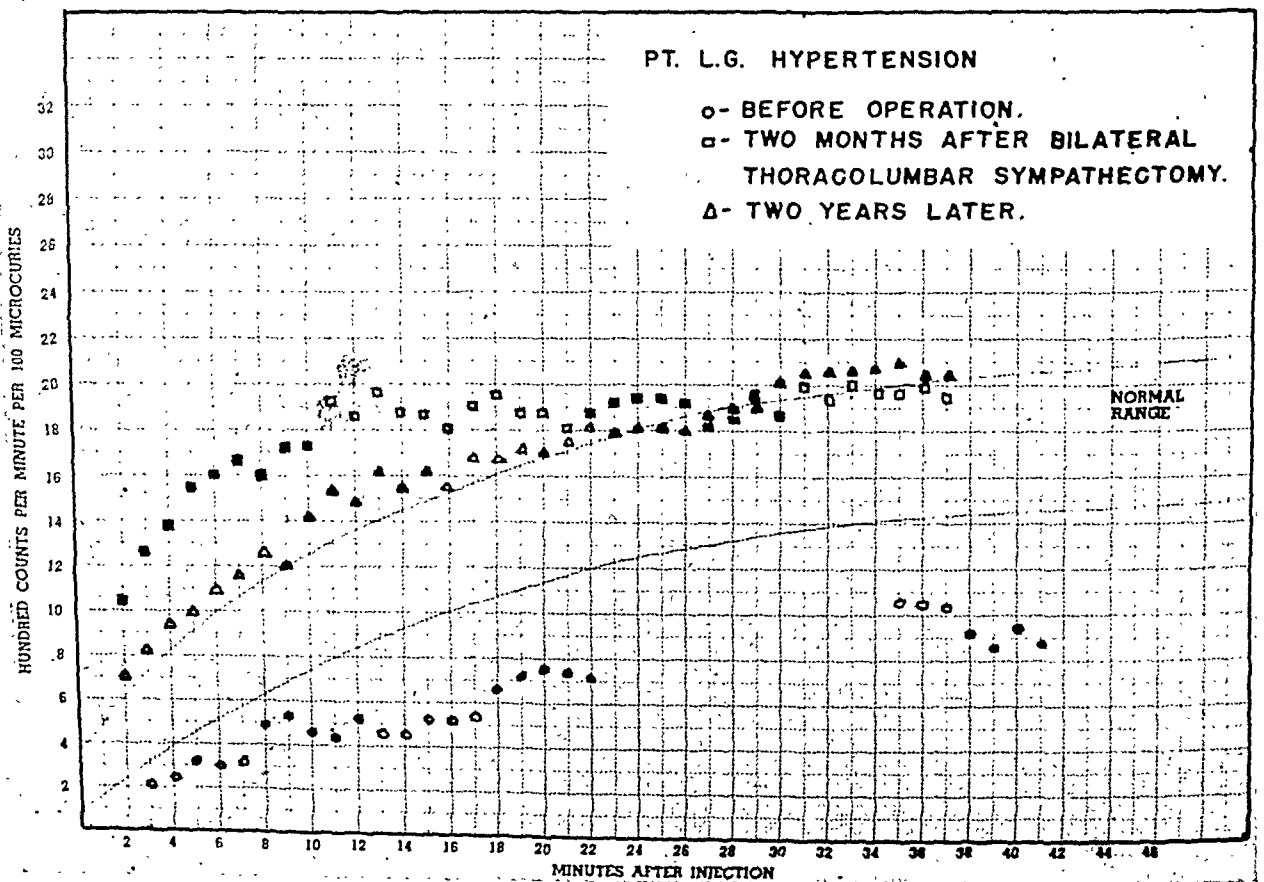


FIG. 4. Radioactive sodium "build-up" curves in a patient with arteriosclerosis and an infected diabetic ulcer, healed by local treatments, and in a patient with severe hypertension relieved by thoracolumbar sympathectomy. For details see text.

binations of these factors (or others). A very high one is due either to inflammation (increased blood supply) or to relaxation of vessel walls by nerve block, sympathectomy, or other reason. Numerous illustrative curves have been published; some typical ones are shown in Figure 4. In all these curves, solid symbols represent counts made against the right foot, open ones against the left. The lower chart shows data for a forty-year-old man with severe hypertension, relieved by bilateral thoracolumbar sympathectomy. The lowest curve (points indicated by circles) represents a test made before the operation. At this time the patient was unable to work and subject to very severe headaches. The two upper curves (squares and triangles) are for tests made two months and two years respectively after the operation. The patient's blood pressure is still rather high but he is symptom-free, and working at an active occupation. Other hypertensives with very low preoperative curves have responded to the operation in a similar manner. On the other hand, those with original curves in or near the normal range are not likely to show a high curve after sympathectomy, and they usually obtain little or no relief from the operation. The explanation appears to be that the very low curve is due, at least partly, to spasm, which is released by the operation. On this basis, it is sometimes possible to foretell whether this operation should be beneficial in a particular case.

In the upper chart the top curve (circles) indicate the original condition in a diabetic arteriosclerotic with an infected ulcer in the sole of the left foot. In view of the apparent good blood supply to the affected foot, conservative therapy was decided upon. The squares show the condition eight months later, when the infection had been healed for five months; both feet were then normal and have continued so. In many such cases it has been possible to avoid amputation by assuring the surgeon of the presence of good blood supply. In cases of gangrene where the initial curve is low and the blood supply

at the foot evidently poor, so that surgery is indicated it has been possible to determine a level below the knee at which adequate blood supply existed, and at which amputation could safely be performed. This has lessened the number of above-the-knee amputations.

Such radiosodium "build-up curves" have been useful aids to the medical staff in diagnosis, prognosis, and the selection of therapy in arteriosclerosis, hypertension, thromboangiitis obliterans, Raynaud's disease, various thrombi and emboli, trench- and immersion-foot, frostbite, and other conditions. Repeated tests on the same individual give information regarding the course of the disease and the efficacy of various therapeutic measures. A study is under way at the present time to test the values of various drugs and physical therapy procedures in a selected group of patients with peripheral vascular disease.

In early work with a certain type of drug therapy, it was found desirable to cut off circulation from the extremities for a few minutes after injection of the material. For this purpose, blood pressure cuffs were applied close to the trunk and inflated to 250 mm. of mercury pressure. In order to determine the efficiency of such a tourniquet, in different types of individuals, radioactive sodium "build-up" studies were made by Quimby and Karnofsky similar to those already described as being used in vascular diseases.<sup>13</sup> A tourniquet was applied to one leg in the usual manner, the other being left free. Radiosodium was injected into an arm, with the counter at the feet. As would be expected, the build-up in the unblocked foot followed the normal pattern already established. In the foot with circulation checked by the tourniquet, various degrees of retardation were found, depending on the obesity of the individual and the amount of pressure applied. Figure 5 shows curves for a very obese individual and a tall rather thin one. Solid points are for the blocked foot, open ones for the unblocked one; the circles are for the thin patient and the squares for the stout one.

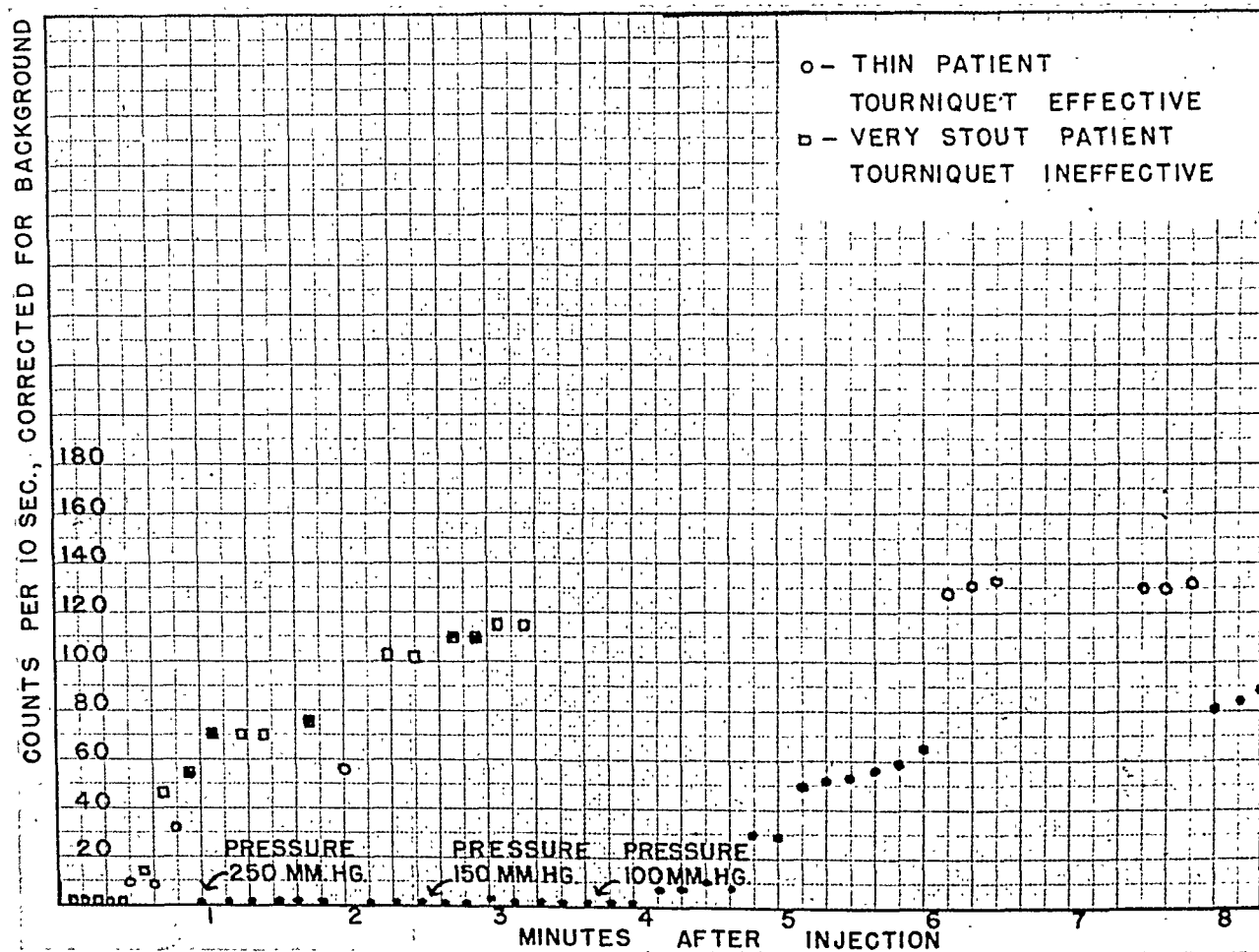


FIG. 5. Radioactive sodium "build-up" curves in patients with tourniquets applied to the upper thigh. Closed symbol, blocked foot; open symbol, unblocked foot.

In the latter, no blood reached the foot until the pressure had been reduced to something between the systolic and diastolic; it then came rapidly. For the stout patient, it was evident that a better type of pressure cuff must be devised.

In an investigation of mechanical methods of artificial respiration, it was desired to know whether blood could be made to circulate by a mechanical respirator if coagulation had not occurred. Pulmonary ventilation alone is not sufficient to produce resuscitation, particularly if the circulation has stopped. Oxygenated blood in the lungs is of no value unless it can be moved out and transported to the vital centers of the nervous system. The question can be answered by the introduction of a tracer substance into the vascular system of an animal immediately following its death by asphyxiation, and recording any movement

of this substance during the application of the resuscitative procedure. Such an investigation was carried out by Thompson, Quimby, and Smith, using radioactive sodium as the tracer.<sup>14</sup> Dogs were anesthetized and an intravenous injection of heparin administered to prevent clotting of the blood. An endotracheal tube with occlusion cuff was inserted and clamped off, and the animal allowed to succumb to obstructive asphyxia. About half an hour after clinical evidence of death, a small quantity of radioactive sodium was injected into a femoral artery or vein (separate studies were made for the two), the counter placed over the carotid-jugular region, and the resuscitator started. After a period of artificial respiration which varied with the type of apparatus used, radioactive sodium arrived in the vessels under the counter, and continued to increase in amount there

as long as the count was followed—from thirty minutes to an hour. In animals with no respirator, or with no heparin, the material was never demonstrated above the diaphragm. It was thus proved that the resuscitative procedures did circulate the blood, and that passive diffusion played no significant part. Figure 6 shows curves for four of the animals, with three different respirators and with none. At the end of the resuscitative efforts, the animal was autopsied and blood taken from various regions was tested for the presence of the radioactive isotope. It was found in both chambers of the heart and in large veins and arteries throughout the body, but not in uniform concentrations. In the living animal, within less than a minute after injection the sodium content of the blood taken from any of the larger vessels is the same, due to the complete mixing after a few

passages through the heart. It has been concluded from this work with dogs that when artificial respiration is employed in asphyxia, the administration of heparin to prevent clotting should increase the possible recovery time of the patient by making it possible to move oxygenated blood even after the heart has stopped beating, although the movement will be slow and the oxygen content not uniform.

Penicillin in an aerosol administered by means of a nebulizer has been found useful in some cases of lung abscess, certain bronchial infections, asthma, etc. In the investigation of a number of problems concerned with its administration, it appeared that radioactive sodium might be an aid, since the vehicle for the penicillin is normal saline. Questions to which answers were sought were:

- a. Does the penicillin actually reach the

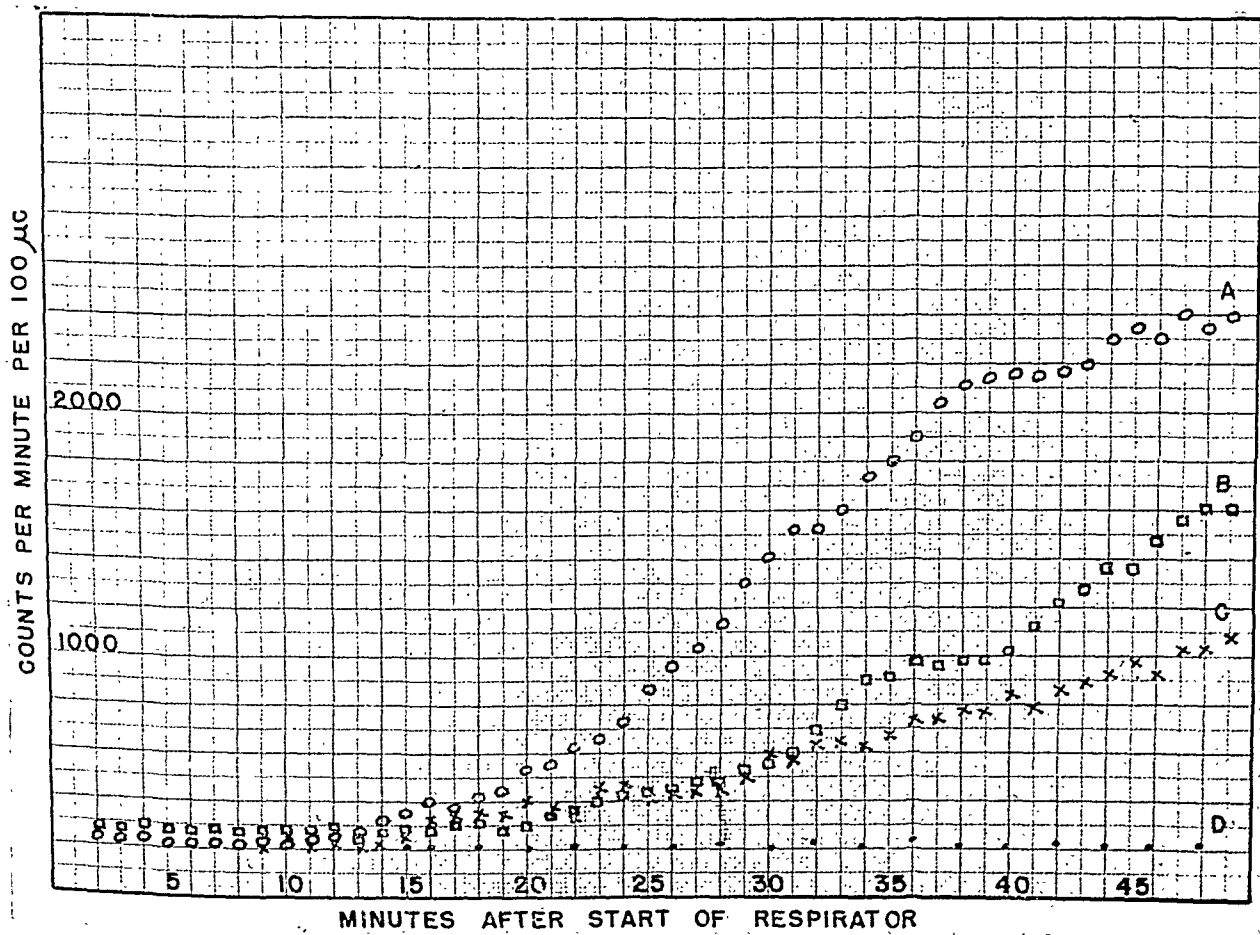


FIG. 6. Radiosodium "build-up" curves demonstrating movement of blood by artificial respiration in dead but heparinized dogs. A, respirator using alternate pressure and suction; B, suction alone; C, pressure alone; D, no respirator.

outermost alvéoli, or is it mainly deposited in the larger bronchi?

b. Does the dose in the alveoli continue to be built up with prolonged inhalation, or is an equilibrium reached after a short time?

c. Can it be determined whether one type of nebulizer is more efficient than another?

d. Can the efficacy of the addition of various substances to the aerosol, to change particle size, be tested?

e. Can optimum conditions of temperature and humidity for the aerosol be established?

Determinations of penicillin blood levels have failed to furnish satisfactory answers to these questions. Talbot, Quimby, and Barach<sup>15</sup> have obtained some information with radiosodium, of which a part is ready for publication. Other studies are planned.

Radiosodium concentrations have not

yet been shown to correspond exactly to penicillin concentrations in the aerosol, but for the preliminary tests it has been assumed that this is the case. Of course the sodium will not remain where it is delivered by the vapor, but will promptly pass through the lung cell walls, enter the blood stream, and be distributed throughout the body. Even so, a considerable amount of information can be gained from measurements made immediately after its administration.

As the tests were set up, the subject started with a known amount of radioactive sodium in the nebulizer, and all exhaled air passed through a train of traps, condensers, and precipitators. At the end of the test, the nebulizer and all parts of the exhaled air train were thoroughly washed and the radioactive isotope content in the washings measured. It could be assumed that the subject retained whatever was not

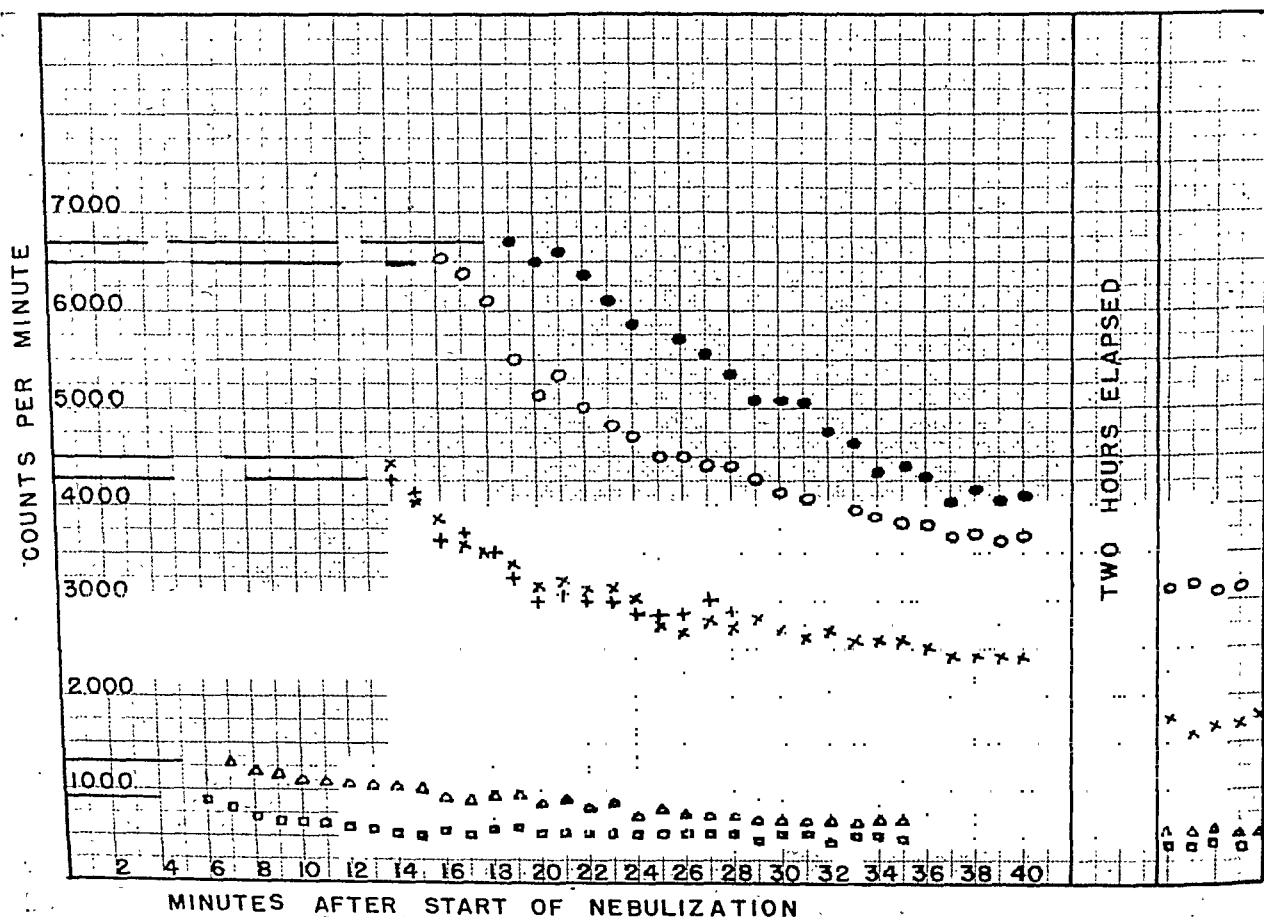


FIG. 7. Curves showing delivery of radioactive sodium to axillary region by inhalation of nebulized normal saline, with subsequent removal of the sodium into the blood stream. For details see text.

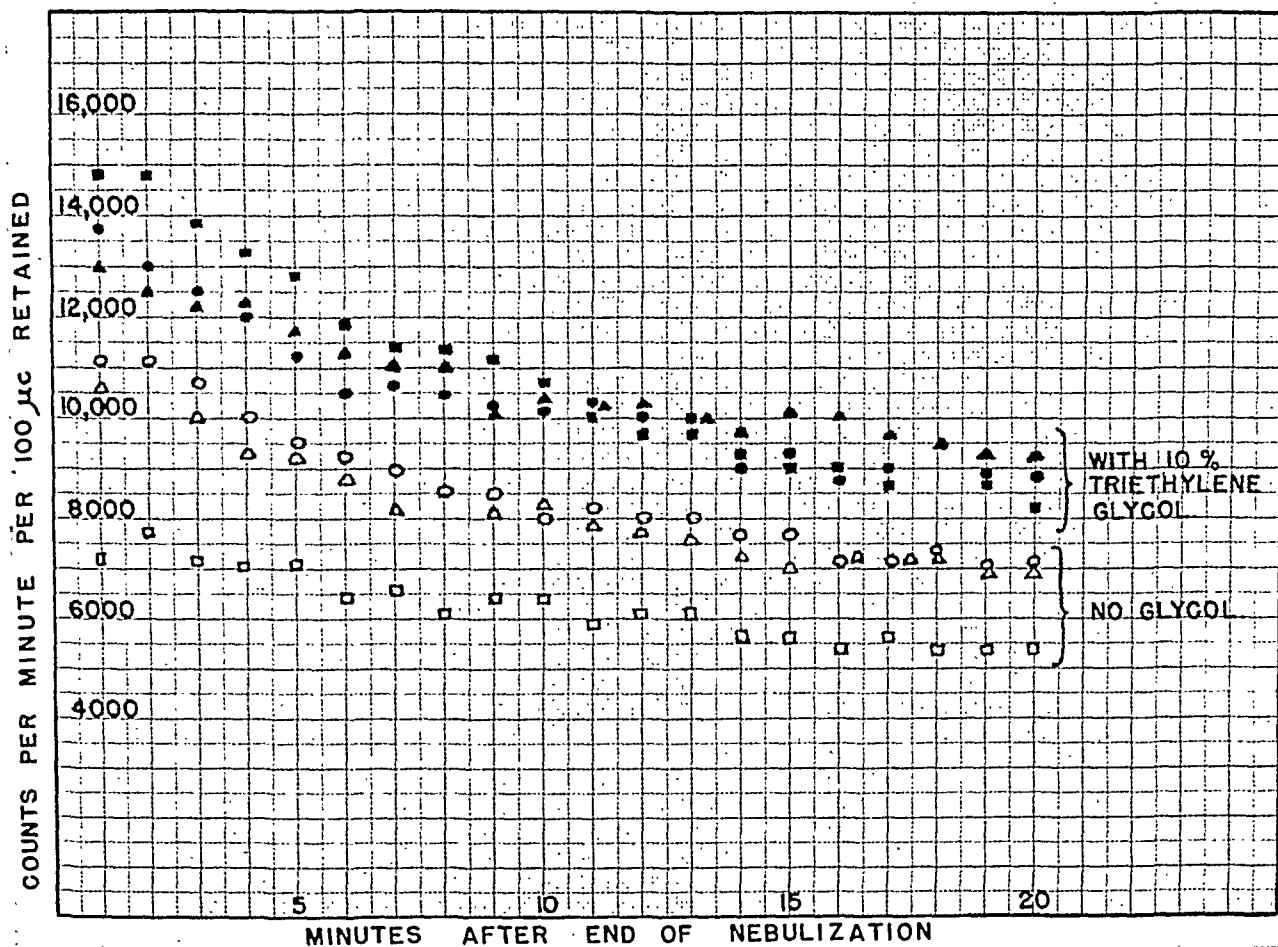


FIG. 8. Curves showing increase of delivery of radioactive sodium to axillary region by addition of 10 per cent triethylene glycol to the saline.

thus accounted for. (It was further possible to make later measurements on the radioactivity of the entire individual and estimate how much sodium he had retained, by comparison with individuals who had swallowed a known amount.) After the subject had inhaled for a predetermined time, he was quickly taken to a room some little distance away, to the Geiger counter. The same shielded counter was used as in the work on vascular disease; it could be placed over different regions and counts obtained. The questions listed above were answered as follows:

a. After a breathing period, counts were taken over the upper esophagus, the sternum, and the lateral lung, high under the axilla. They were essentially the same in all three positions. It appeared that material was definitely being delivered at the outer part of the lung. However the question was raised that, since sodium gamma

rays are so penetrating, it might be possible that readings obtained at the axilla were actually due to material near the center of the body. Accordingly other subjects swallowed amounts of the isotope equal to those retained by the inhalers. In such cases the count at the axilla was less than one-third of the count after nebulization. Evidently a considerable part of the count is due to material far out in the lung.

b. Individuals inhaled for different times, material being added to the nebulizer every five minutes, so that the volume there available did not change greatly. Figure 7 shows levels attained by three pairs of individuals breathing about five, ten, and fifteen minutes, against the same concentration of material. The solid line in each case starts at the beginning of inhalation, breaks indicate pauses for adjustment or refilling the nebulizer. The rapid fall of the curves indicate the departure of



sodium from the lungs. Equilibrium appears to be attained fairly promptly however, for the counts at two hours are only slightly lower than those for one-half hour.

c. Three different nebulizers tested with the same individuals showed no appreciable differences. However the mechanical differences among these were not marked; it is probable that greater variations would result in different uptakes of sodium.

d. The addition to the solution of 0.2 cc. of 5 per cent triethylene glycol made no difference in sodium uptake, but when the same amount of 10 per cent glycol was used, the count in every case was higher than for the plain saline (Fig. 8).

e. When a rebreathing system was used, if the balloon for rebreathed air was kept immersed in hot water, thus assuring warmth and humidity in the inhaled material, the count was always higher than for the same individual when the rebreathed air was cold.

Much work remains to be done on this problem; the data here presented merely indicate the possibilities.

In all such experiments as the ones described, using radioactive tracers, it must be assured that the accompanying amount of radiation is so small as not to constitute a danger to the subject, and not to influence the experimental findings. Marinelli has published a method whereby the radiation dose can be estimated for material administered and remaining within the body until its complete decay.<sup>16</sup> On this basis, 1 microcurie of radioactive sodium per kilogram of body weight delivers a whole body radiation of about 0.11 r over an effective period of about two days, when both the beta and gamma rays are considered to be entirely absorbed within the body. The accepted tolerance dose for continuous irradiation is 0.1 r daily<sup>17</sup> hence it is safe to use tracer doses of 2 or 3 microcuries of radioactive sodium per kilogram of body weight, and to repeat them a few times at reasonable intervals. *This dosage does not apply to any other radioactive isotope.* In

most of the work described herein, doses have been of the order of 100 microcuries, which is usually less than 2 microcuries per kilogram.

The foregoing paper presents a condensed account of some uses of a single radioactive element, sodium 24, as a tool in experimental medicine. The information is collected partly from the literature and partly from personal experience. It is not suggested that this covers the entire field of work with sodium; there is doubtless much more, both published and unpublished. As radio-isotopes become more readily available, and their measurement somewhat simplified, it is to be expected that work of this type will often become standard experimental procedure.\*

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# TISSUE DOSAGE IN RADIO-ISOTOPE THERAPY\*

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THE biological action of roentgen rays is, of course, due to the effects on living cells of high-speed secondary electrons produced by the primary roentgen rays. The beta rays from a radioactive isotope are also high speed electrons. These beta rays can therefore be expected to produce tissue effects similar to those produced by roentgen rays. The beta rays have a maximum range of only a few millimeters of tissue. Therefore, the beta radiation doses are usually confined almost exclusively to the tissue actually containing the radioactive isotope, and the dosage rate at any time is proportional to the concentration of the isotope in the tissue.

It might be desirable to express the radiation doses produced by the beta rays in some fundamental energy units, such as ergs per gram of tissue. Ordinarily, however, the doses are converted into equivalent roentgens, with air as the standard substance. A number of authors have discussed special and general cases of the estimation of beta ray doses from radioactive isotopes.<sup>1,2,3,4,5,6,7,8,9,10</sup>

One roentgen of roentgen rays, by definition, produces 1 electrostatic unit, or  $1/4.80 \times 10^{-10} = 2.08 \times 10^9$  ion pairs, per cc. (0.001293 gm.) of air, or  $1.61 \times 10^{12}$  ion pairs per gram of air. An average of 32.5 electron volts (e.v.) is expended<sup>11</sup> to form each ion pair in air, therefore the roentgen corresponds to the absorption of  $5.24 \times 10^{13}$  e.v. of energy (which is about 83 ergs) per gram of air. An amount of beta radiation which delivers  $5.24 \times 10^{13}$  e.v. per gram of air will deliver approximately the same amount of energy per gram of tissue, and may be called one roentgen-equivalent-physical (rep.). Thus:<sup>12</sup>

$$1 \text{ rep} = 83 \text{ erg/gm. tissue.}$$

The individual beta rays from any single radioactive isotope may have any kinetic energy between zero and some maximum energy  $E_{\max}$  million electron volts (Mev.) which characterizes the spectrum. For a large number of disintegrating atoms, there will be some average kinetic energy  $E_{\text{av}}$  Mev. per disintegrating atom, which can represent the beta-ray spectrum ( $E_{\text{av}}$  should include conversion electron lines if they are present). If we call  $C$  the local concentration of radioactive isotope in millicuries (mc.) per gram of tissue, and arbitrarily define the millicurie as  $3.7 \times 10^7$  disintegrating atoms per second, then the tissue dosage rate,  $R$ , may be written:

$$R = \left[ \frac{3.7 \times 10^7 C \text{ disint.}}{\text{sec. gm.}} \right] \left[ \frac{10^6 E_{\text{av}} \text{ e.v.}}{\text{disint.}} \right] \\ \left[ \frac{1 \text{ rep.}}{5.24 \times 10^{13} \text{ e.v./gm.}} \right] \left[ \frac{60 \text{ sec.}}{\text{min.}} \right] \\ = 42.4 C E_{\text{av}} \text{ rep/min. (for } C \text{ in mc./gm.) (1)}$$

If the concentration of radioactive isotope is to be measured instead in rutherfords (rd) per gram of tissue (1 rd =  $10^6$  disintegrating atoms per sec),<sup>12</sup> then:

$$R = 1.15 C E_{\text{av}} \text{ rep/min. (for } C \text{ in rd/gm.)}$$

Thus<sup>6</sup> for 12.6 hr.  $\text{I}^{130}$ , where  $E_{\text{av}} = 0.29$  Mev., 1 mc./gm. delivers 12.3 rep/min. while for 8.0 day  $\text{I}^{131}$ , where  $E_{\text{av}} = 0.20$ , 1 mc./gm. delivers 8.5 rep/min.

The detailed shape of the beta-ray spectrum is known only for a very few isotopes, so very precise values of  $E_{\text{av}}$  are usually not known at present. Within an accuracy of perhaps  $\pm 15$  per cent,  $E_{\text{av}} = E_{\max}/3$  for all simple beta ray spectra and  $E_{\text{av}}/E_{\max}$  is generally smaller for the isotopes which have what are called "forbidden

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

spectra" than for "allowed spectra." In the case of isotopes with compound beta-ray spectra, such as  $I^{130}$ , the values of  $E_{av}$  for each component of the beta-ray spectrum may be estimated separately, and then weighted in proportion to the relative abundances of the components, in order to obtain  $E_{av}$  for equation (1). For pure line-spectrum alpha ray emitters, such as polonium,  $E_{av}$  is simply the total energy of disintegration, i.e. the energy of the alpha ray plus the energy of the recoil nucleus.

The dosage rate  $R$  of equation (1) is usually to be regarded as a maximum value, corresponding to the dosage rate within a mass of tissue whose dimensions are greater than the range of the alpha or beta radiation, and in which the distribution of the radioactive isotope is uniform.

Representing  $E_{av}$  as  $E_{max}/3$ , equation (1) leads to an approximate rule-of-thumb which is often useful, namely: a concentration of one microcurie per kilogram produces about  $E_{max}/50$  (rep/day). Alternatively: 1 mc./kg. gives about 20  $E_{max}$  (rep/day), or:

$$R = 60 CE_{av} \text{ rep/day } (C \text{ in } \mu\text{c/gm. or mc./kg.})$$

The activity of each pure radioactive isotope decreases exponentially with time, falling to half of any initial value in a time  $T$ , the so-called "half-period." Then the average life of all the radioactive atoms of a given species can be shown to be  $1.44 T$ .

Then, if the isotope concentration  $C$  in mc./gm. has the values  $C_1$  at time  $t_1$  and  $C_2$  at some later time  $t_2$ , and if no isotope was lost by excretion from the tissue, the total dosage delivered will be:

$$D = \int_{t_1}^{t_2} R dt = 1.44 T (R_1 - R_2) \text{ (rep)} \quad (2)$$

where the term  $(R_1 - R_2) = 42.4 E_{av}(C_1 - C_2)$ , and  $T$  is in minutes because  $R$  is in rep/min. Here  $(C_1 - C_2)$  can be thought of as millicuries-destroyed per gram of tissue.

If, as is usually the case, some isotope is absorbed or excreted by the tissue then  $C$  is no longer a simple exponential function of time, and equation (2) takes the form

$$D = \int_{t_1}^{t_2} F C_0 e^{-t/1.44T} dt \quad (3)$$

where  $F$  is the fractional amount of isotope present at any time, by virtue of biological processes, and  $F=1$  corresponds to the value of isotope concentration,  $C$ , used in equation (1), and occurs at a time  $t$  when:

$$R = 42.4 C E_{av} = R_0 e^{-t/1.44T}. \quad (4)$$

In the usual case, total dosage must be determined by graphical or numerical integration of equation (3) (for example see Table I of reference 6).

It will be noted from equation (2) that a long-lived isotope (e.g.  $I^{131}$ ), if retained by the tissues, delivers a total dose which is greater than the total dose from a short-lived isotope (e.g.  $I^{130}$ ) if the two isotopes have the same initial dosage rates,  $R$ . Conversely, if a particular total dose,  $D$ , is to be given, the dosage rate,  $R$ , must be smaller if a long-lived isotope is used than if a short-lived isotope is used. Of course, identical biological effects cannot be expected from identical total doses,  $D$ , delivered at different rates.

Some radioactive isotopes<sup>12</sup> used for therapy (e.g.  $Mn^{52}$ ) have very complicated nuclear spectra, involving orbital electron capture, complex gamma-ray spectra, internal conversion electrons, and continuous beta-ray spectra. In such cases, special attention must be given to the energy delivered by radiations other than the continuous beta rays.\*

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# ARTIFICIALLY PREPARED RADIOACTIVE ISOTOPES AS A MEANS OF ADMINISTERING RADIATION THERAPY\*

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IN A recent article in Collier's magazine the theme of which was that the new chemotherapeutic agents are not quite the miracle drugs they were first heralded as being, Dr. O. H. P. Pepper of the University of Pennsylvania is quoted as having said: "Every new drug when it comes out goes through what looks like a typhoid fever curve. First the fever goes 'way up, while every doctor uses the drug for everything; then it goes 'way down, while the drug is universally condemned. Finally, the fever finds its level, and stays there."<sup>6</sup>

Radioactive isotopes as therapeutic agents have definitely passed through the first two phases of such a curve, and the time has now arrived when it should be possible to re-evaluate these agents and "find their level."

Radioactive isotopes of only two elements, phosphorus and iodine, have been used extensively in the treatment of disease and proved to be of real value. The therapeutic use of these two elements will be discussed in detail. Brief mention will be made of the limited amount of work which has been done in various laboratories on the therapeutic use of radioactive isotopes of sodium, calcium, strontium, and manganese.

## RADIOACTIVE PHOSPHORUS

The nature and properties of radioactive phosphorus, and the experimental work upon which the therapeutic use of this isotope is based have been reviewed in detail in previous publications.<sup>1-7</sup> We will discuss here only the most important properties and characteristics of  $P^{32}$ .

Figure 1 illustrates the nuclear changes involved in the production of radioactive

phosphorus and its transformation into stable sulfur. The nucleus of stable phosphorus contains 15 protons and 16 neutrons giving a total mass of 31. When the nucleus is bombarded with energetic deuterons, one of two things may happen. When a nucleus is bombarded by a deuteron having an extremely high energy, both the proton and the neutron may enter the nucleus with resultant conversion of the atom into  $S^{33}$ .  $S^{33}$  is unstable and instantaneously disintegrates into stable sulfur (by the emission of a neutron), or into radioactive phosphorus (by the emission of a proton). On the other hand, when the nucleus of stable phosphorus is bombarded by a relatively low energy deuteron, only the neutron enters the nucleus while the proton is repelled. The new atom which is formed is radioactive phosphorus which has a mass of 32. Radioactive phosphorus disintegrates by the emission of an electron or beta ray whereupon one neutron disappears and a proton takes its place. Thereupon the radioactive phosphorus becomes stable sulfur.

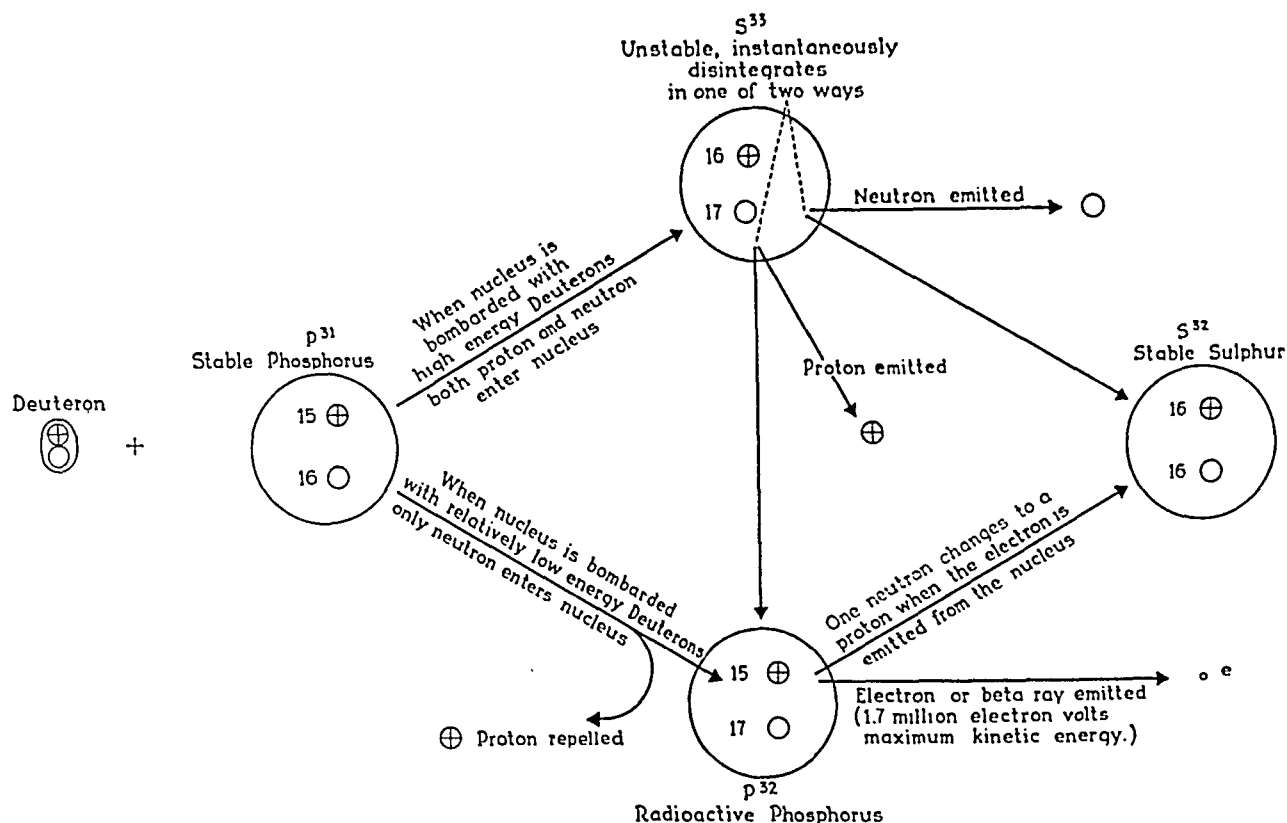
The electron or beta ray which is emitted when  $P^{32}$  disintegrates is the means by which radioactive phosphorus exerts its effect on tissues. These beta rays have energies as high as 1.8 million electron volts; their average energy is approximately 0.6 million electron volts. The *maximum* range of penetration of these rays through the body tissues is approximately 0.7 centimeters. The half-life of  $P^{32}$  is 14.3 days.

Studies by various investigators have shown that when radioactive phosphorus is administered to animals or humans it is selectively withdrawn from the blood by certain tissues and cells. The tissues in

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

which  $P^{32}$  accumulates in largest amounts are those tissues which are usually primarily involved in polycythemia vera, the leukemias, and the lymph node diseases. The amount of phosphorus taken up by

leukemia than in the corresponding organs of normal mice. Figure 2 shows graphically the results of this study. A single dose of labeled phosphorus was administered to two groups of mice; one normal and one



Schematic presentation of nuclear changes involved in the production of radioactive phosphorus and its transformation into stable sulphur. Protons are marked with a plus because of their positive charge, while neutrons are left blank. The number of electrons which revolve about the nucleus: 1) is equal to the number of protons in the nucleus, 2) determines the chemical identity of the atom. Since both stable and radioactive phosphorus have 15 protons, they behave alike chemically.

FIG. 1. Radioactive phosphorus produced by deuteron bombardment of stable phosphorus (only nuclei are represented). Reproduced with permission of the Editor of the *Journal of Laboratory and Clinical Medicine*, 1946, 31, 112.

any given tissue is dependent on the total phosphorus content of the tissue, the rate of phosphorus turnover by the tissue, and the rate at which new tissue is being formed. Thus, a relatively large portion of an administered dose of  $P^{32}$  always accumulates in the bone as the total phosphorus content of this tissue is high, and the cells in the marrow ordinarily multiply rapidly.

Studies by Lawrence and his associates<sup>8</sup> have shown that radioactive phosphorus is taken up much more rapidly and in two to three times larger amounts by the lymph nodes and spleens of mice with lymphatic

with lymphatic leukemia. The animals were sacrificed at various intervals, and the labeled phosphorus content of the tissues was determined. The amount of radio-phosphorus found in different organs is expressed in per cent of the administered dose present per gram of wet tissue. There was only slightly more  $P^{32}$  in the bone and liver of the leukemic mice than in these organs in the normal mice, but the lymph nodes and spleens of the leukemic animals took up from two to three times as much  $P^{32}$  as did these organs in the normal mice.

Tuttle and his associates<sup>9</sup> have demon-

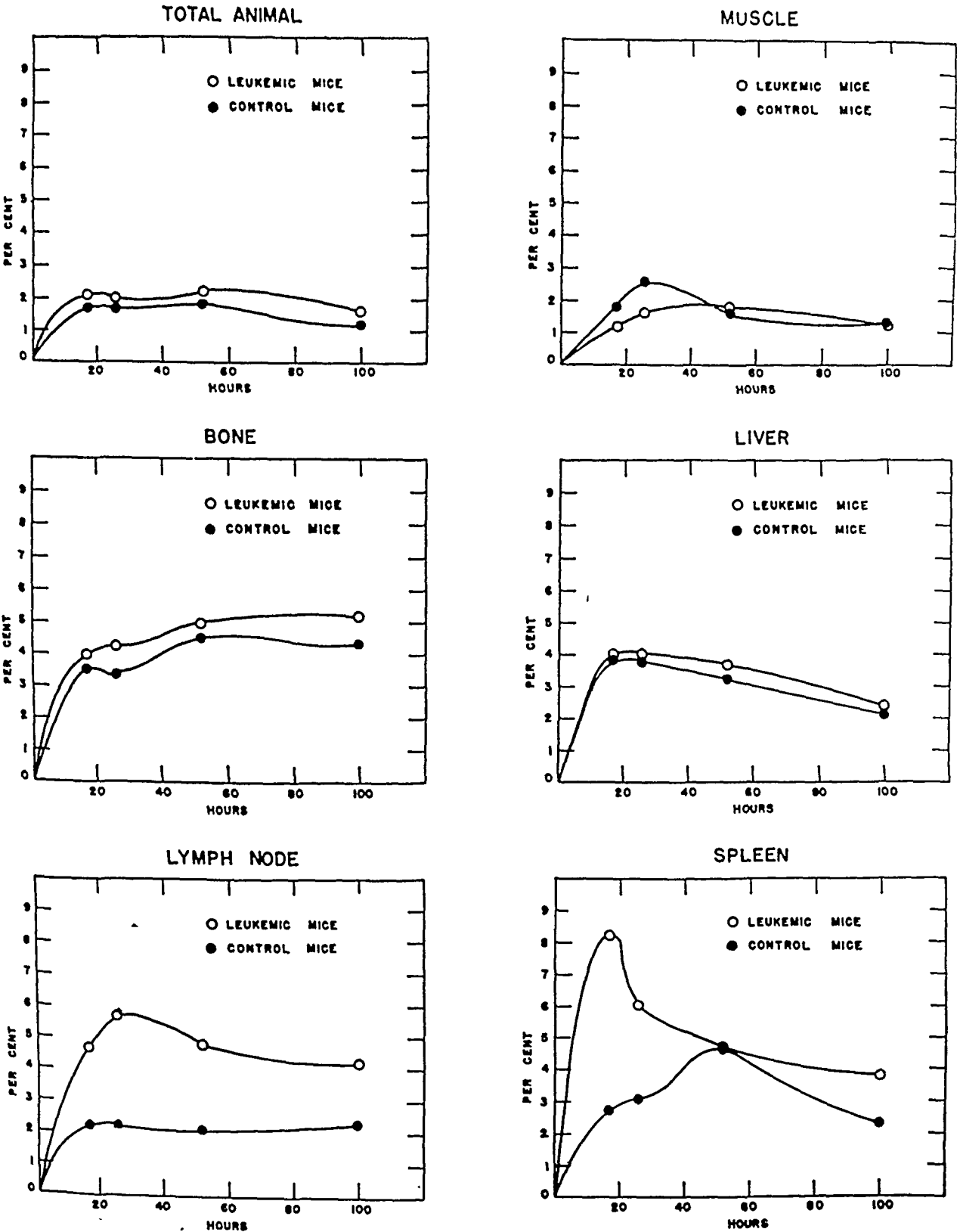


Fig. 2. Distribution of radiophosphorus in the tissues of normal and leukemic mice. Reproduced with the permission of Dr. John H. Lawrence from the *Journal of Clinical Investigation*, 1940, 19, 267.

strated that most of this increased phosphorus content of the leukemic lymphoid organs is due to the greatly increased amount of  $P^{32}$  which accumulates in the nucleoprotein fraction of these tissues. Figure 3 shows the fate of a single dose of  $P^{32}$  given intraperitoneally to another large group of normal and leukemic mice. In this



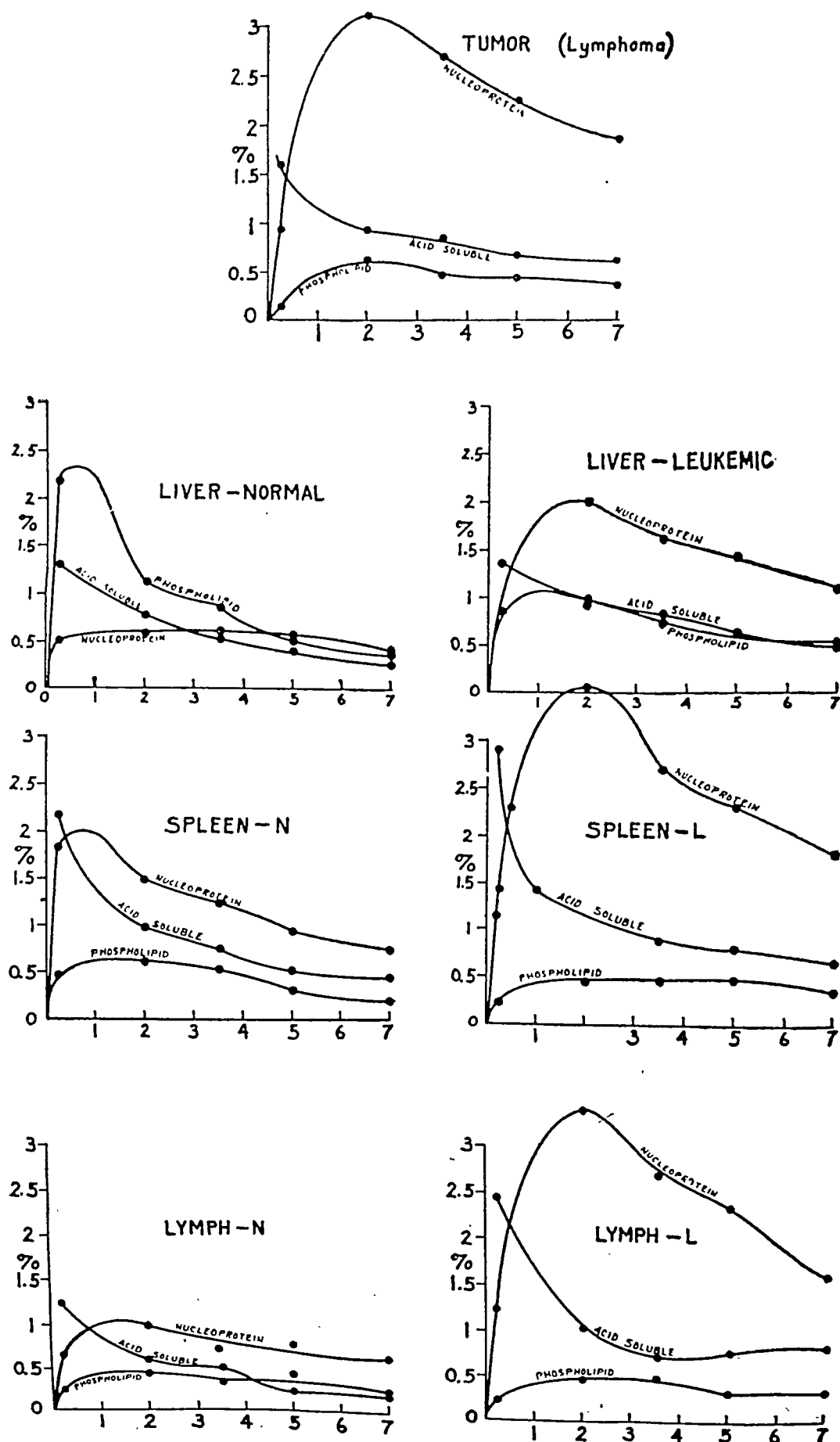


FIG. 3. The comparative uptake of labeled phosphorus in normal and leukemic mice. Reproduced with the permission of the authors<sup>9</sup> from the *Journal of Clinical Investigation*, 1941, 20, 57.

experiment various tissues were removed at intervals after the injection, the different organic phosphorus fractions were chemically extracted, and the  $P^{32}$  content of each fraction was determined. The nucleoprotein fraction of lymph nodes, spleen, and tumor tissue from the leukemic mice contained much more  $P^{32}$  than did the nucleoprotein fraction of corresponding organs in the normal animals. Thus, phosphorus, including radioactive phosphorus if it is available, is taken from the blood stream and used in the synthesis of nucleoproteins at a much more rapid rate by the leukemic cells than by cells in the corresponding normal tissues.

Similarly, the distribution of radioactive phosphorus in the tissues obtained at autopsy of patients who have been treated with  $P^{32}$  has been studied by several groups of investigators. In leukemic patients the greatest concentrations of  $P^{32}$  have usually been found in the bone marrow, lymph nodes, spleen, and liver. These findings are in agreement with those previously described for leukemic mice. Many such determinations have been made in our laboratory. Table 1 illustrates the results of such analyses on 3 of our patients. The first patient had chronic myelogenous leukemia. The radioactivity of the various tissues is expressed in microcuries per gram of wet tissue calculated as of the time of death. In this particular case the bone marrow had three times as much radioactivity as any other organ. In chronic myelogenous leukemia the marrow usually has greater activity than any other organ, but this marked discrepancy between the activity of the bone marrow as compared to the liver and spleen is unusual. The next patient had leukosarcoma and in this case the activity of the liver and spleen was greater than that of the bone marrow. The last patient, who had multiple myeloma, showed the greatest activity in the tumor tissue. In spite of this he responded very poorly to treatment apparently due to the fact that the tumor cells are less sensitive to radiation than are normal marrow cells.

In the past there has been considerable

confusion regarding the proper dosage of radioactive phosphorus for various diseases. Part of this confusion was due to the fact that there is considerable variation in the susceptibility of different patients to  $P^{32}$  just as in the case with roentgen rays.

TABLE I  
RADIOACTIVITY OF TISSUES OBTAINED  
AT AUTOPSY  
(Expressed in Microcuries per Gram  
of Wet Tissue)

	Patient: L. E. Chronic myeloid leukemia	Patient: M. T. Leuko- sarcoma	Patient: R. R. Multiple myeloma
Bone marrow	0.263	0.037	—
Lymph node	0.063	0.019	—
Spleen	0.081	0.053	0.066
Liver	0.088	0.098	0.102
Kidney	0.061	—	0.059
Muscle	0.020	0.024	—
Brain	—	0.012	0.008
Intestine	—	—	0.031
Tumor	—	—	0.108

However, there is another factor involved. We sent samples of radioactive phosphorus to several laboratories where this isotope is being used extensively, and to the National Bureau of Standards, and compared the figures obtained in our laboratory with the figures obtained when the sample was assayed in these institutions. Widely divergent values were obtained. As a result of this disturbing discrepancy, Dr. Martin Kamen of the Mallinckrodt Institute re-evaluated the standard that we had been using and concluded that it was in error by a factor of 2.3. The National Bureau of Standards' figures were correct, and it would help greatly to clear up this source of confusion if all institutions who are assaying isotopes for therapeutic use would check their standards with the Bureau. I want to emphasize that all dosage figures given in our previous publications must be multiplied by 2.3 to convert to the corrected millicurie which we now use. The dosages given in this paper are expressed in the corrected millicurie.

Next, we will consider the therapeutic results which have been obtained in the treatment of various blood dyscrasias, lymphomas, and other malignant neoplastic diseases with radioactive phosphorus. The various disorders for which this treatment has been tried will be considered in the approximate order of its effectiveness.

*Polycythemia Vera.* There are eight papers in the medical literature which describe

other patient died with the blood and bone marrow findings of myelogenous leukemia.

Figure 4 illustrates the response to  $P^{32}$  therapy in a sixty-five year old woman with polycythemia vera. Her symptoms began in January, 1940, and consisted of fatigability, anginal pains, a feeling of fullness and occasional pain in the left upper quadrant, intense itching, and weight loss. Physical examination revealed a blood pressure of 185/115, a ruddy complex-

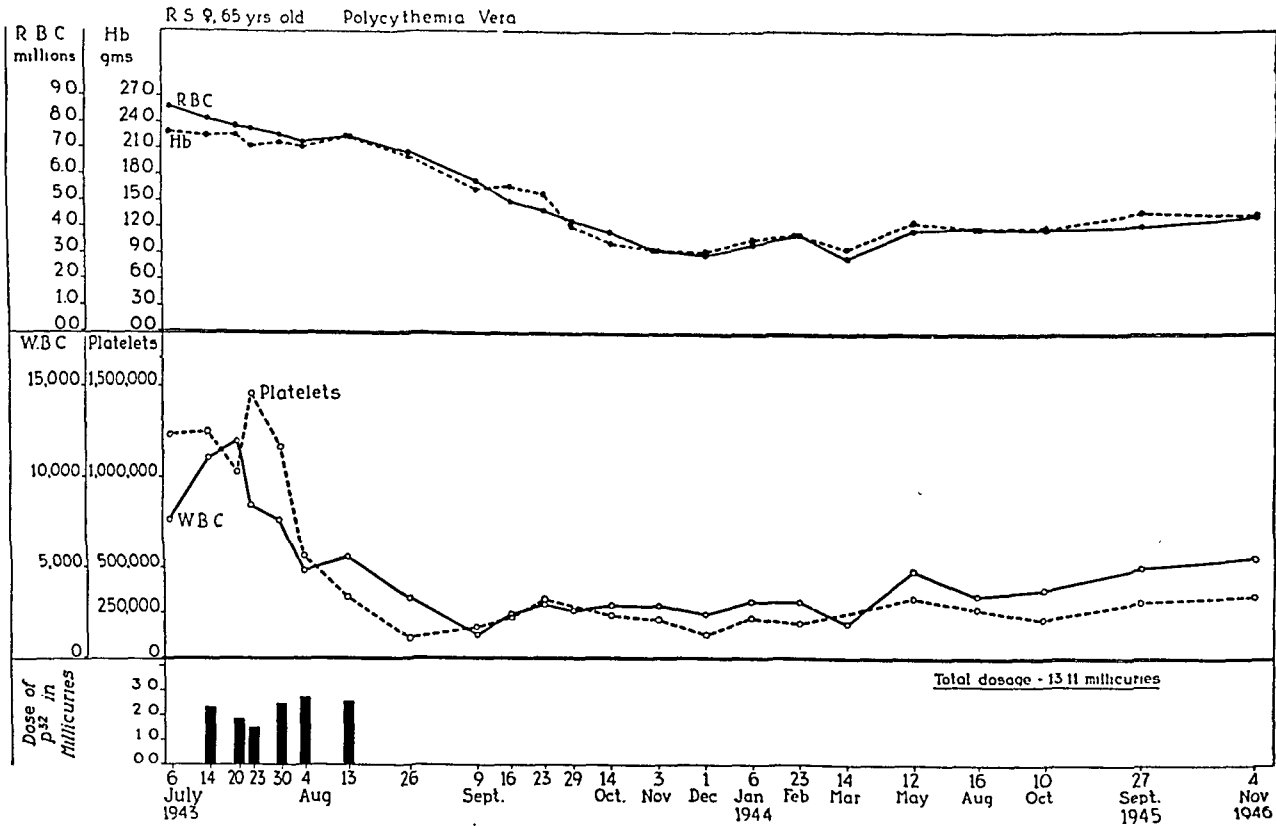


FIG. 4

clinical results obtained in the therapy of polycythemia with radioactive phosphorus. These papers are based on a study of 78 patients. There is substantial agreement in all these reports that excellent clinical and hematologic remissions can be obtained in the majority of patients.

During the last four and one-half years, 43 patients with polycythemia vera have been treated with  $P^{32}$  at the Mallinckrodt Institute. All of these patients are now either asymptomatic or at least markedly improved except 2 who have died. One of the deaths was due to suicide, and the

ion with moderate cyanosis, marked splenomegaly and slight hepatomegaly.

The erythrocyte count just before treatment was started in July, 1943, was 8,110,000; the hemoglobin value was 22.3 grams; the leukocyte count was 11,100; and the platelets, 1,230,000. During a period of four weeks the patient was given 13 millicuries of  $P^{32}$ . The leukocyte count and the platelet count began to fall about a week after treatment was started, but the erythrocyte count showed no significant drop until about a month after the beginning of therapy. Three months later the patient had a slight anemia (red count about 4,000,000) as well as a well marked leukopenia and thrombocytopenia. Symptomatically she was greatly improved

at this time. The blood counts very slowly increased until a year after the treatment the red cell count, the leukocyte count, and the platelet level were all normal. She has had no symptoms since September, 1943, except occasional pains in the shoulders and arms attributable to cervical arthritis. In December, 1946—three and one-half years since her first course of treatment—her blood was still normal in all respects. This patient was obviously overtreated, and we now recommend from 6 to 8 millicuries for the first course of treatment. However, this case illustrates clearly the prolonged remissions which can be obtained with  $P^{32}$  therapy.

Several features regarding the response of patients with polycythemia to  $P^{32}$  therapy need to be emphasized. First, there is marked variation in the response of different patients to the same dosage of radioactive phosphorus. A dosage which produces perfect control of polycythemia in one patient may produce profound anemia in another patient. In general, the heavier the patient and the greater the severity of the disease, the larger will be the required dosage, but the exact amount required to restore the blood counts to normal in any particular case cannot be predicted in advance. Second, the erythrocyte count never shows a significant decrease in less than three weeks and the latent period is frequently considerably longer than this. It is usually two to three months after treatment is started before the red blood cell count becomes stabilized at a new (lower) level. Thus it is desirable to allow two or three months to elapse after the first injection before deciding if further injections are needed. The last point I wish to emphasize is that hematologic and symptomatic remissions produced by  $P^{32}$  therapy have lasted anywhere from five months to more than four years in our patients. The average interval before a second course of treatment is required is about thirteen months.

Careful study of the patients who have been treated at the Mallinckrodt Institute revealed that all patients who had headaches, dizziness, or lacrimation and burning

of the eyes were at least partially relieved of these symptoms, whereas fatigability, aching pain in the extremities, and itching were at least partially relieved in more than 90 per cent of the patients having these symptoms. Cyanosis disappeared in all the patients who had this finding, and the spleen and liver invariably decreased in size.

It is not possible to draw any conclusions from the data now available regarding the effect of  $P^{32}$  therapy on the duration of life of patients with this disease. Furthermore, these patients have not been followed for a sufficiently long period of time to permit a comparison of the duration of life of patients treated with  $P^{32}$  with the duration of life in individuals treated with roentgen rays or by phlebotomies.

*Myelogenous Leukemia.* There are ten reports in the literature dealing with the therapeutic effectiveness of radioactive phosphorus in myelogenous leukemia. All investigators have agreed that  $P^{32}$  is of little or no value in the treatment of acute myelogenous leukemia. There is also agreement that in chronic myelogenous leukemia administration of radioactive phosphorus will usually restore the leukocyte count to normal or approximately normal levels, and that a rise in the erythrocyte count frequently follows. This hematologic improvement is quite consistently accompanied by definite symptomatic improvement.

Figure 5 illustrates the hematologic response to  $P^{32}$  therapy in a thirty-five year old woman. She had had fatigability and numerous large, spontaneous bruises for about three months when we first saw her in September, 1943. The leukocyte count at that time was 175,000; the erythrocyte count was 3,480,000; and the differential revealed 27 per cent metamyelocytes and 14 per cent myelocytes. During the first three years of treatment she received 33 injections of  $P^{32}$  totalling 69.3 millicuries. She is at present (January, 1947) asymptomatic. The leukocyte level has remained below 20,000 except for a few isolated counts throughout this interval, and the red cell and thrombocyte levels have remained higher than they were prior to treatment. No transfusions have been given.

Analysis of the 51 cases treated at the Mallinckrodt Institute shows that weakness, by far the most common symptom, was completely or partially relieved in about 90 per cent of the patients. All other common symptoms except nervousness and anxiety were completely relieved in at least 50 per cent of the patients. Abnormal physical signs including fever, petechiae, bleed-

clinic during the period of this study were treated with  $P^{32}$ , whether the disease was acute or chronic, early or terminal. Some of the patients lived only two to three days after treatment was started, and these were included in our series. It appears, therefore, that  $P^{32}$  therapy prolongs life by only a few months, and there is no significant difference in this regard between  $P^{32}$  and roent-

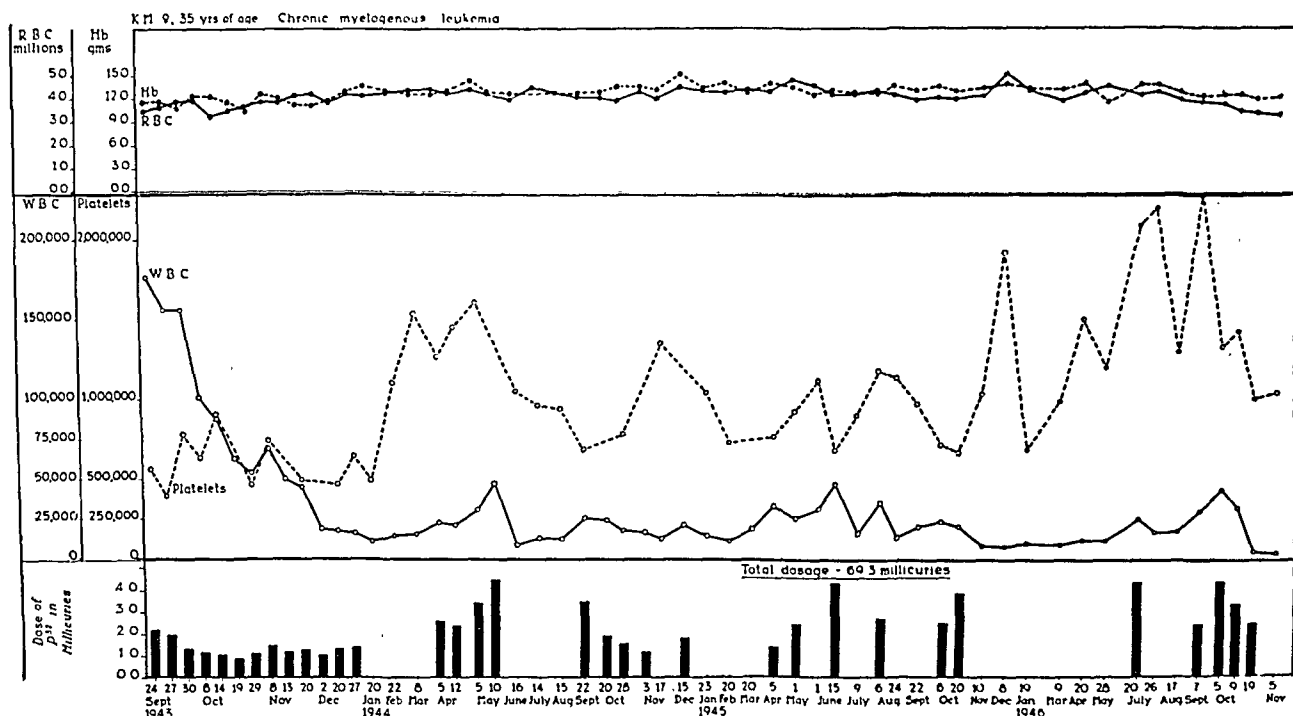


FIG. 5

ing from the nose and gums, enlarged lymph nodes, splenomegaly and hepatomegaly disappeared or partially subsided in at least two-thirds of the cases.

An important problem which remains to be answered is the effect of  $P^{32}$  on the duration of life of patients with myelogenous leukemia. Minot, Buckman and Isaacs<sup>10</sup> have reported the average duration of life from the first symptom until death in a large series of patients who received no radiation was 3.0 years, and in another series of patients treated with roentgen radiation was 3.5 years. The average duration of the disease from the onset of symptoms until death in our patients who have already died was 3.6 years. All patients with myelogenous leukemia seen in our

gen therapy. Both forms of therapy definitely prolong the period of useful, relatively symptom-free life.

*Lymphatic Leukemia.* There are eleven reports in the literature dealing with the therapeutic effectiveness of radioactive phosphorus for lymphatic leukemia. Most of these investigators agree that  $P^{32}$  is effective in the majority of cases of chronic lymphatic leukemia in restoring the leukocyte count to near normal levels, reducing the size of enlarged lymph nodes and spleen, and temporarily relieving symptoms. Data presented by Erf and his associates,<sup>11</sup> a report by Craver,<sup>12</sup> and our own experience all indicate that  $P^{32}$  is somewhat less effective in chronic lymphatic leukemia than in chronic myelogenous leukemia.

However, Warren<sup>13</sup> found a higher percentage of his patients with chronic lymphatic leukemia were helped by this treatment than was the case among his patients with chronic myelogenous leukemia.

Figure 6 illustrates the results of therapy in a fifty-eight year old coal miner with chronic lymphatic leukemia. He developed weakness and fatigability in August, 1942, and in No-

two years has been unable to work and has required repeated transfusions.

Analysis of the data on 47 cases of chronic lymphatic leukemia treated at the Mallinckrodt Institute shows that there was less striking symptomatic relief in this group than in the chronic myelogenous group. Furthermore, a significant decrease in the size of the lymph nodes, spleen and

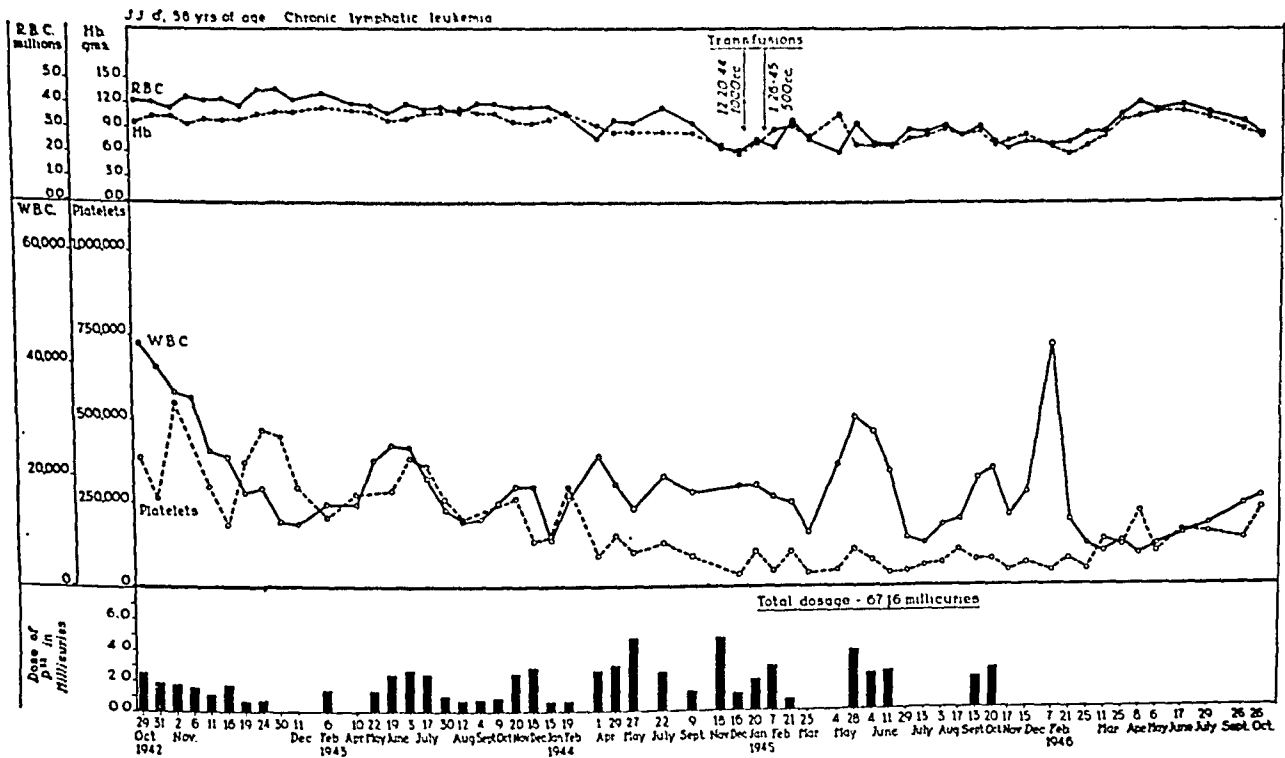


FIG. 6

vember, 1942, he began to have aching pain in the left upper quadrant of the abdomen. On physical examination in October, 1942, he was found to have moderate enlargement of the cervical, axillary, and inguinal lymph nodes, and the spleen extended 8 cm. below the costal margin. The leukocyte count at that time was 40,300; the erythrocyte count was 4,060,000; the platelet count was 382,000; and 81 per cent of the white blood cells were lymphocytes.

About one week after the initial injection of P<sup>32</sup> the patient began to feel stronger, and three weeks later he was able to return to work in the coal mines. He continued to be practically asymptomatic until April, 1944, when he began to have petechiae, bleeding from the nose and gums, and weakness. His platelet count has been below 100,000 ever since then. He was still alive in December, 1946, but for the last

liver following therapy was less common in the patients with chronic lymphatic leukemia than in the patients with chronic myelogenous leukemia.

In any type of chronic leukemia, roentgen radiation is more effective in some cases than P<sup>32</sup> in bringing about a rapid reduction in the size of the spleen or lymph nodes. Therefore, roentgen therapy should be used whenever the prompt reduction of nodes or the spleen is necessary to relieve symptoms or remove pressure on some vital organ. Roentgen irradiation may be used to supplement radioactive phosphorus for this purpose.

*Other Diseases.* Radioactive phosphorus has not been found to be of any value in

the treatment of any of the acute forms of leukemia. None of the 10 cases of monocytic leukemia which we treated showed any improvement.

Various investigators have reported a few cases of Hodgkin's disease, lymphosarcoma, and multiple myeloma in which improvement occurred following  $P^{32}$  therapy. In our experience none of these conditions respond as favorably to radioactive phosphorus as they do to roentgen therapy. A few cases of lymphoepithelioma, malignant melanoma, carcinoma of the gallbladder, carcinoma of the breast, Ewing's tumor, mycosis fungoides, and xanthomatosis have been treated with  $P^{32}$  at the Mallinckrodt Institute and in other clinics. There is no convincing evidence that this treatment is of any value in any of these neoplastic diseases.

*Summary.* In our opinion radioactive phosphorus is of proved value only in polycythemia vera and the chronic forms of leukemia.

We consider  $P^{32}$  the most effective therapeutic agent available at the present time for polycythemia vera. Complete hematologic and almost complete symptomatic remissions can be produced with  $P^{32}$  in the vast majority of patients, and remission from a single course of treatment may last for from six months to three and one-half years or longer with an average of about thirteen months.

$P^{32}$  therapy produces at least as complete clinical and hematologic remissions as roentgen irradiation in chronic myelogenous leukemia. Radioactive phosphorus treatment has the practical advantage of complete freedom from radiation sickness. The duration of life from the first symptom until death of the patients treated at the Mallinckrodt Institute suggests that  $P^{32}$  therapy prolongs life to approximately the same extent as does roentgen therapy (about six months).

In the treatment of chronic lymphatic leukemia,  $P^{32}$  is probably as satisfactory as, but no better than roentgen irradiation. Roentgen irradiation is the preferred treat-

ment when rapid reduction in the size of enlarged lymph nodes and spleen is important.

In our experience,  $P^{32}$  has not proved to be of value in any of the other conditions for which it has been tried.

#### RADIOACTIVE IODINE

Most of the preparations of radioactive iodine which have been used therapeutically have consisted of a mixture of two isotopes,  $I^{130}$ , which has a half-life of 12.6 hours, and  $I^{131}$ , whose half-life is eight days. Radioactive iodine is prepared by deuteron bombardment of metallic tellurium in a cyclotron, or it can be prepared in a pile. Immediately after a short bombardment the twelve hour iodine has about ten times the radioactivity of the eight day iodine isotope which is produced simultaneously. With longer bombardments, the ratio of eight day iodine to twelve hour iodine increases. Following the bombardment, the iodine is chemically separated from the tellurium and is converted into sodium or potassium iodide. The final solution which is administered to patients consists of the radioactive sodium iodide plus non-radioactive carrier sodium iodide in distilled water.

$I^{130}$ , the twelve hour isotope, and  $I^{131}$ , the eight day isotope, both emit beta rays and gamma rays. From the standpoint of the effect on tissues, the beta rays are the more important.

*Accumulation of Radioiodine in the Thyroid Gland.* Hertz and his associates<sup>14,15</sup> were the first to study the rate at which radioiodine is accumulated in the thyroid gland. They found that in rabbits, significant accumulation of iodine in the thyroid gland occurs within a few minutes after administration of the tagged element. They also found that the uptake was much greater in thyroids which had previously been rendered hyperplastic. The normal thyroid was found to collect up to 80 times the quantity to be expected from uniform diffusion into the general body tissues; the

hyperplastic thyroid collected up to several hundred times the quantity expected from uniform diffusion.

Hamilton and Soley<sup>16,17</sup> showed that in humans the same principles apply. They compared the uptake of labelled iodine by the thyroids of normal controls and of patients with various types of thyroid disease in situ. This was done by placing a Geiger counter tube against the neck directly over the thyroid gland and taking readings at various intervals after the administration of a single dose of labelled iodine. None of these individuals had received iodine before the radioisotope was given. Figure 7 shows the uptake curves which they obtained when 14 mg. of iodine was given as sodium iodide which was labelled with radioiodine.

Hamilton and Soley<sup>18</sup> then repeated these experiments under the same conditions with the exception that each subject received a test dose which contained a total of approximately 0.1 microgram of iodine as sodium iodide. Figure 8 shows the uptake curves. A marked increase in uptake occurred in all four clinical types. This is what you would expect as the total iodine content of the thyroid is relatively small and its capacity to accumulate iodine is limited. Note that toxic goiters not only accumulated a larger percentage of the administered dose, but also retained it for much longer periods of time when the dose of iodide was small. This emphasizes the importance of avoiding excessive dilution of the radioactive substance with stable iodide when the material is used therapeutically.

*Therapeutic Results.* Hertz and Roberts<sup>19</sup> recently published a three to five year follow-up on 28 patients with hyperthyroidism treated with therapeutic doses of radioactive iodine. The radioiodine they used consisted at the time of administration of over 90 per cent twelve hour isotope and the remainder of the eight day isotope. The material was given *orally*. Because of the experimental work which we have just summarized, they kept the total amount

of iodide administered below 2 mg. of iodide.

Of the 28 patients in this series, 5 subsequently had a subtotal thyroidectomy. All 5 of these patients developed "hypo-metabolism." In the remaining 23 cases no operation was performed. Three to five years after treatment 20 of these patients were no longer thyrotoxic. The thyroid decreased in size in all of these patients, and in all but three the gland became no longer palpable. No undesirable radiation effects were observed in any of these patients. Although 5 of the 20 patients who were not operated on developed basal metabolic levels of -15 to -20 per cent, none of them developed permanent myxedema.

From an analysis of their data Hertz and Roberts arrived at the following recommendations and conclusions:

1. No patient should be treated with radioiodine if he has had previous routine iodine therapy unless such treatment has been stopped for at least one month prior to administration of the isotope.

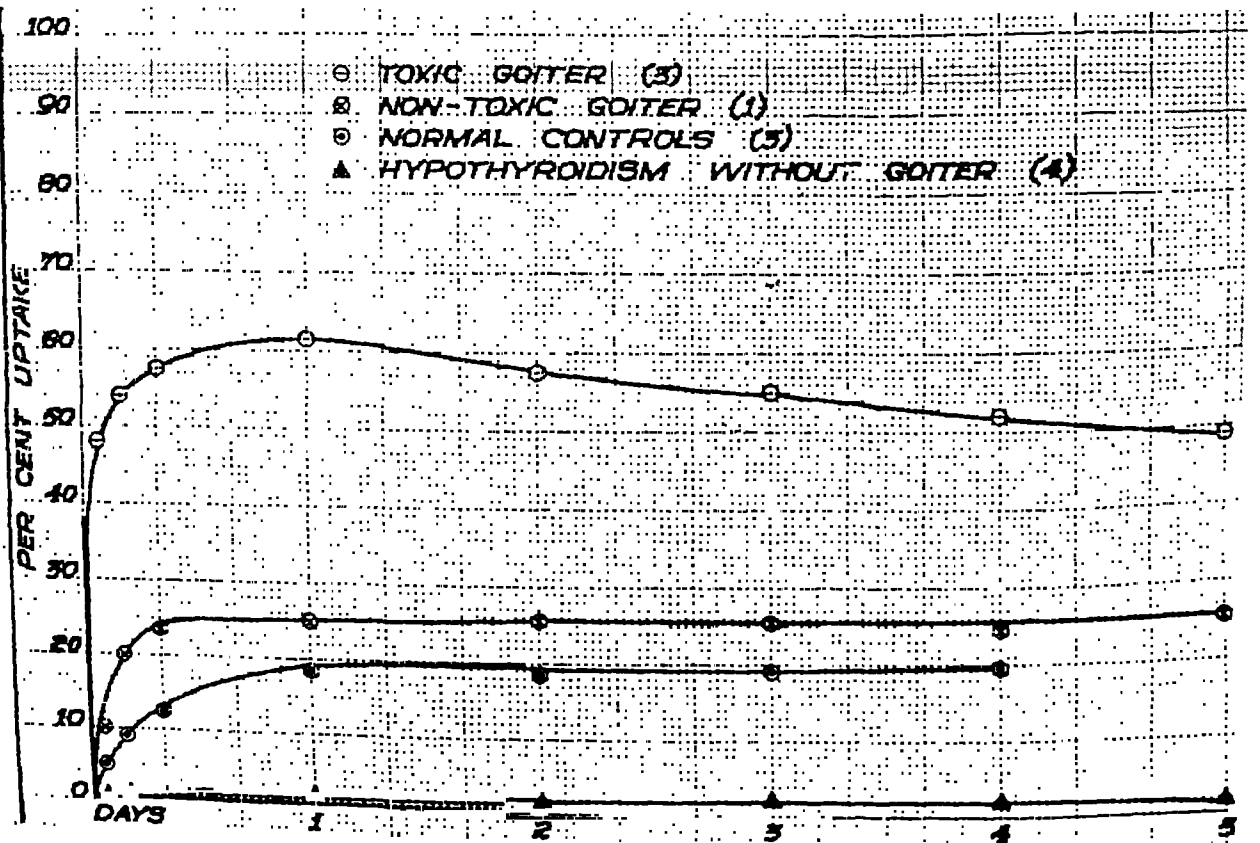
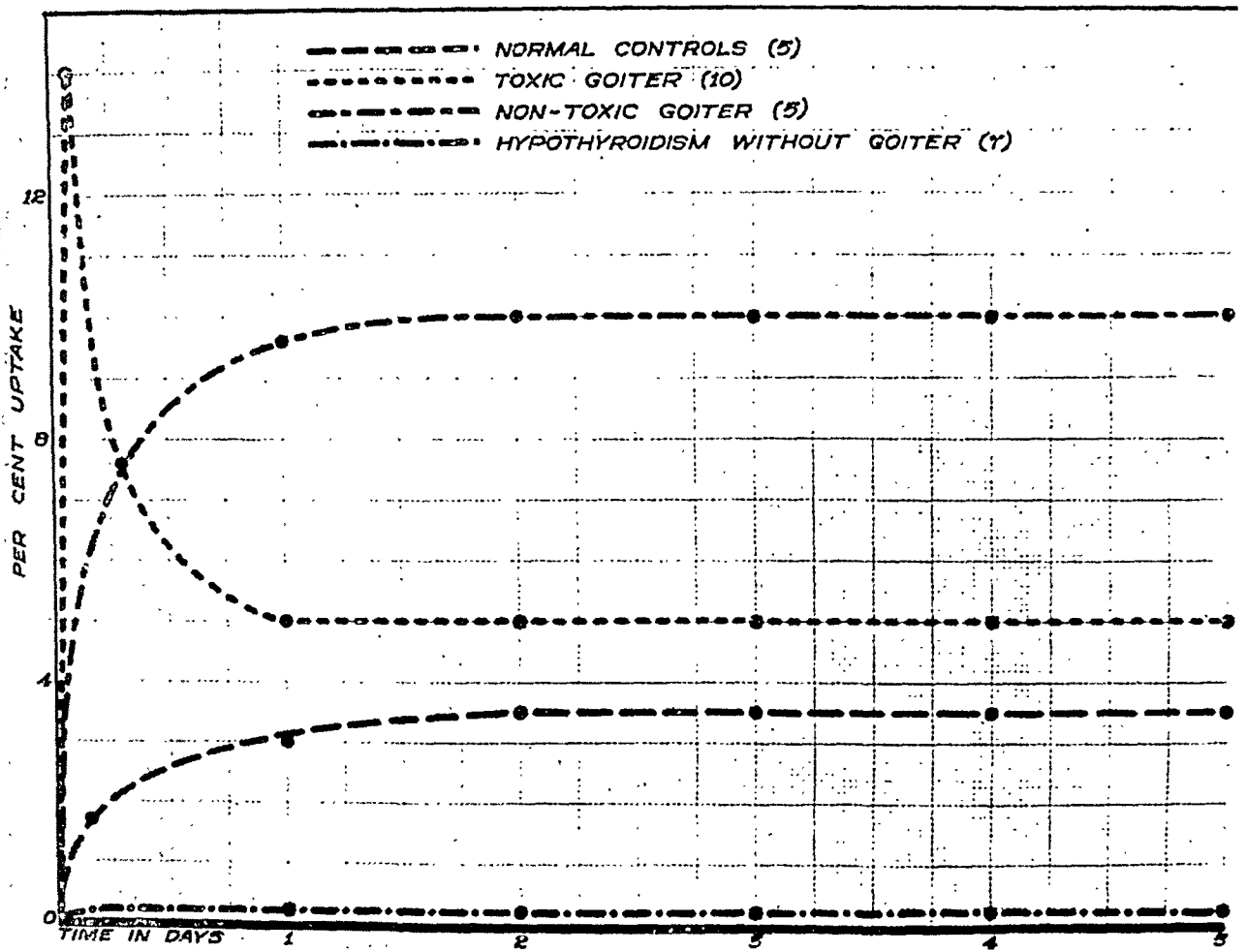
2. It is unwise at present to treat patients having large goiters with secondary involutional changes with radioiodine as surgery might be needed on a purely mechanical basis even though detoxification by radioiodine could be accomplished.

3. These investigators advocate routine iodination, starting one to three days after the administration of radioiodine, or as soon as the uptake is known to be adequate.

4. In their experience the therapeutically effective dosage range is from 5 millicuries to 25 millicuries given as a single dose. The choice of the dose is based largely on clinical estimation of the size of the goiter being treated.

Chapman and Evans<sup>20</sup> have also published a recent report on the treatment of hyperthyroidism with radioactive iodine. Their paper was based on a study of 22 cases. The solution they used, like that of Hertz and Roberts, contained about 90 per cent twelve hour isotope and 10 per cent eight day isotope. Figure 9 is taken from their paper, and illustrates the results obtained. This man had classic signs and





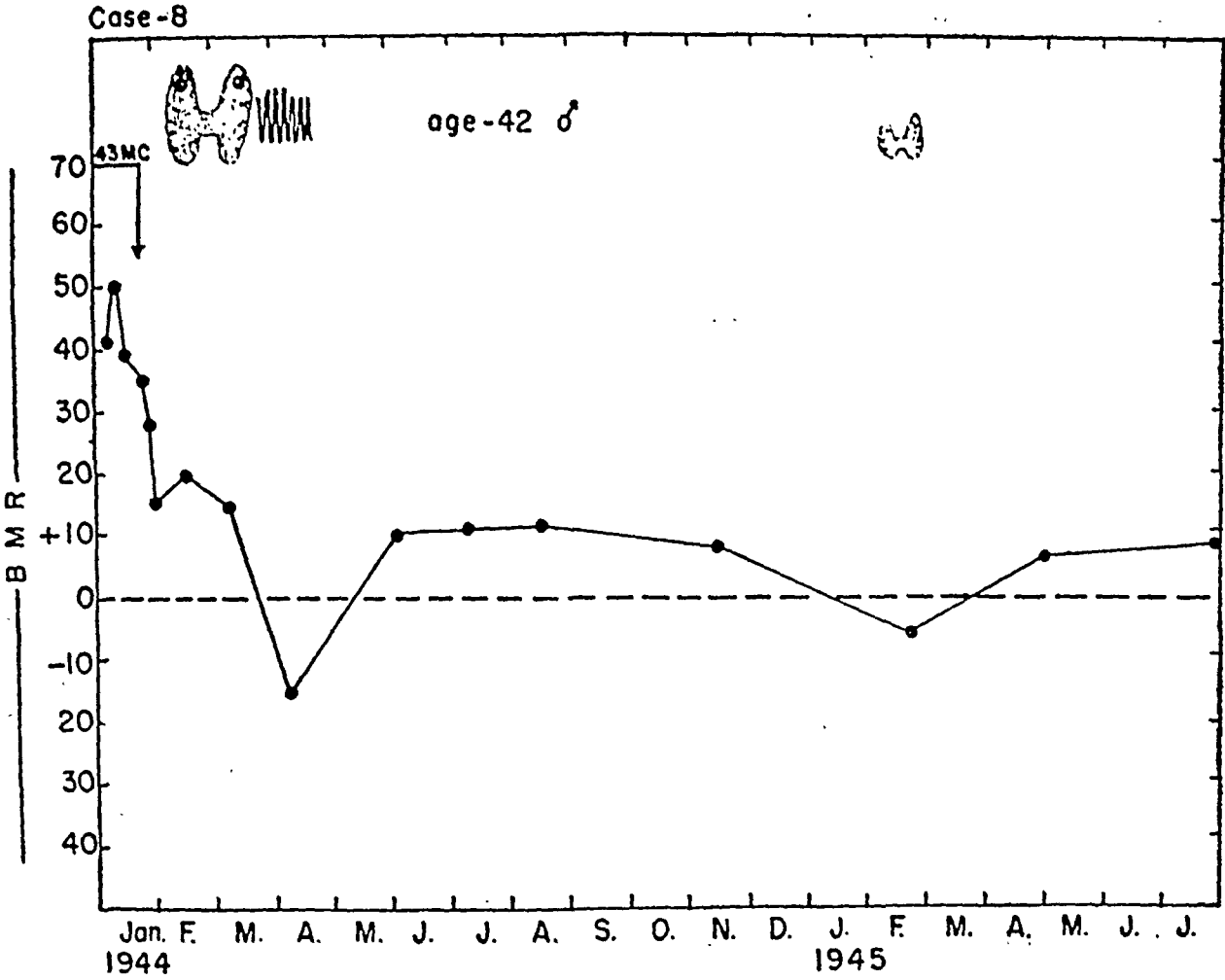


Fig. 9. Reproduced with the permission of Dr. Earl M. Chapman from the *Journal of the American Medical Association*, 1946, 131, 90.

symptoms of moderately severe hyperthyroidism of six months' duration. The thyroid was symmetrically enlarged to about three times normal size. The basal metabolic rate was +44 and +52. On January 19, 1944, he drank 48 cc. of a solution containing 43 millicuries of radioiodine. That evening he was nauseated and next day his temperature rose to 102°F. By January 21 his temperature returned to normal and he felt much better. His hyperthyroidism subsided progressively, and a year and a half later his basal metabolic rate was still within the normal range.

Chapman and Evans employed considerably larger doses than did Hertz and Roberts. The average total dose Chapman and Evans gave their patients was 40 to 50 millicuries, and the largest single dose given was 79 millicuries. Myxedema developed following treatment in 4 patients, and 2 patients, although improved after treatment, still had mild hyperthyroidism. Reactions which resembled roentgen sickness were observed in 6 patients following large doses of radioactive iodine. Several patients who had not responded well to thiouracil or routine lugolization subse-

Fig. 7 and 8. Uptake of radio-iodine by the intact thyroid glands of normal human subjects and of patients with different types of thyroid disorders. In the experiment shown in Figure 7 (above), each subject received 14 mg. of iodine as sodium iodide which was labelled with radio-iodine. In the experiment represented by Figure 8 (below), each subject received a total of only 0.1 of a microgram of iodine as sodium iodide which was labelled with radio-iodine. Reproduced with the permission of Dr. Joseph G. Hamilton from *Radiology*, 1942, 39, 555.

quently responded well to radioactive iodine. Chapman and Evans do not recommend ordinary iodine therapy following administration of radioactive iodine; they consider this unnecessary.

*Treatment of Carcinoma of the Thyroid.* When radioiodine first became available it was hoped that this substance might offer an effective method of treating cancer of the thyroid. Obviously, if thyroid carcinoma cells selectively accumulate radioiodine, it should be possible to effectively

confirmed by other investigators. The more malignant and anaplastic a thyroid cell becomes, the more completely it loses the ability to take up and utilize iodine. Rhoads<sup>21</sup> recently made the statement that "certainly not more than 15 per cent of all thyroid cancers have been shown to pick up appreciable amounts of radioactive iodine."

However, an occasional thyroid cancer does utilize iodine. Marinelli, Leiter and Seidlin studied a patient some years ago

TABLE II

RADIO-IODINE UPTAKE OF THE THYROIDS AND OF TUMOR TISSUE IN 2 PATIENTS WITH CARCINOMA OF THE THYROID AFTER ORAL ADMINISTRATION OF 14.0 MG. IODINE CONTAINING RADIO-IODINE

Diagnosis	Total Weight of Tissue, Gm.	Total Iodine in Tissue, Mg.	Radio-Iodine Uptake in Tissue, Per Cent	Iodine per Gram of Tissue, Mg.	Radio-Iodine Uptake per Gram of Tissue, Per Cent
Carcinoma of Thyroid					
A. Thyroid tissue	5	1.2	1.2	0.24	0.24
B. Cancerous tissue	138	<0.2	0.13	<0.002	0.001
C. Regional metastases	139	<0.2	0.05	<0.002	0.0004
Carcinoma of Thyroid					
A. Normal thyroid tissue	20	9.0	4.5	0.45	0.23
B. Cancerous tissue	90	<0.2	0.2	<0.002	0.0022

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irradiate not only the primary tumor but all the recognized and unrecognized metastases by simply giving a few intravenous injections. With this in mind, Hamilton and Soley<sup>18</sup> studied the localization of radioiodine in the cancerous thyroid tissue of 4 patients. Their results indicated that the malignant portions of the thyroid had no significant capacity to take up iodine. Table II illustrates the relative uptake of radioiodine by the normal thyroid tissue as compared with the malignant thyroid tissue in 2 of these patients after oral administration of 14 mg. of iodine containing radioiodine. The cancerous tissue took up very little of the labeled iodine, and metastatic tumor tissue took up even less.

These observations have now been amply

who had had a thyroidectomy for carcinoma (discussed by Rhoads<sup>21</sup>). Following removal of the gland the patient continued to show manifestations of hyperthyroidism. As the thyroid gland itself had been completely removed this was clear evidence that metastases were utilizing iodine to synthesize thyroxin. Tracer doses of iodine were given and when a Geiger counter was passed over the body metastases were detected which had not been visualized by ordinary roentgen-ray methods. The patient was then given a therapeutic dose of radioiodine and marked clinical improvement occurred. Several years later the patient was still alive and the tumor appeared to be no longer active. It should be kept in mind that this type of therapy is

effective in only one rather rare form of thyroid tumor, and the vast majority of thyroid cancers are totally unaffected by radioiodine.

#### INSOLUBLE COLLOIDAL SUSPENSIONS OF RADIOACTIVE ISOTOPES

Jones, Wrobel and Lyons<sup>22</sup> injected a colloidal suspension of insoluble chromic phosphate prepared from radioactive phosphorus into laboratory animals and found that the material was selectively concentrated in the reticuloendothelial cells of the body. The highest concentrations were found in the liver, spleen and bone marrow. These studies suggested the possibility of using some such preparation in the treatment of Hodgkin's disease, reticulum cell sarcoma and other tumors arising in the reticuloendothelial system. Since then radioactive chromic phosphate as well as radioactive iron phosphate have been given to a few human patients with various lymphomas with equivocal results.

Allen, Hempelmann and Womack<sup>23</sup> at the Mallinckrodt Institute of Radiology injected a suspension of radioactive chromium phosphate around the periphery of transplanted spontaneous mammary adenocarcinomas in mice. In most of the animals this treatment was followed by complete disappearance of the tumors. A few human patients with basal cell carcinoma of the face were similarly treated with very satisfactory results. These investigators emphasized that this type of tumor can be readily cured by surgery or roentgen therapy, and their interest in radioactive chromic phosphate was purely experimental.

Hahn<sup>24</sup> has recently been studying the effect of intravenously administered colloidal suspensions of manganese dioxide containing radioactive manganese in the treatment of Hodgkin's disease, chronic lymphatic leukemia, monocytic leukemia, reticuloendotheliosis, and lymphosarcoma. Manganese 52 has a half-life of 6.5 days but when the isotope is prepared in a cyclotron a small amount of manganese 54 with

a half-life of 310 days is always produced. Manganese can be dispersed in a colloidal sol of ultramicroscopic particle size using gelatin as a supporting colloid. Inspection of the sol in an ultramicroscope shows definite brownian movement. The particles are therefore much smaller than colloidal chromic phosphate particles. and Hahn believes this favors a more efficient and even phagocytosis of the material by reticuloendothelial cells throughout the body. Manganese is prepared by bombarding chromium, and it can be chemically separated from the chromium. As the manganese salt which is given to the patient is carrier-free, the actual amount of the element employed is so minute as to be well below the toxic range. Hahn states that early therapeutic results have shown promise, but the work is still in the preliminary stage. More recently Hahn has been carrying out similar investigations using radioactive gold sols.

#### RADIOACTIVE ISOTOPES OF CALCIUM AND STRONTIUM

The administration of radioactive calcium has been suggested as a means of irradiating certain bone tumors. This has not proved practical because of the difficulty of preparing radioactive isotopes of calcium and because of the relatively low energies of the radiations emitted. Strontium is physiologically interchangeable with calcium and an isotope of strontium which emits energetic beta rays can be prepared with relative ease. This has been employed in the treatment of bone tumors.<sup>25</sup> The radioactive strontium is accumulated in large amounts in those portions of the bone where active cell multiplication is taking place such as at the epiphyses and also at the site of fractures. Osteogenic sarcoma tissues will take up some of the isotope but the clinical results have been very disappointing and this type of therapy has been abandoned.

#### RADIOACTIVE SODIUM

Isotopes of sodium have been tried in the

treatment of leukemia.  $\text{Na}^{24}$  is the isotope which has been commonly employed. It has a half-life of 14.8 hours and emits both beta rays and gamma rays. Tremendous quantities of  $\text{Na}^{24}$  can be prepared by a very short bombardment. This element is distributed evenly to the tissue fluids throughout the body and there is no selective uptake by bone or bone marrow. However, chronic leukemia will respond favorably to radioactive sodium therapy just as it responds to general body roentgen radiation. Radioactive sodium is easy to prepare and inexpensive.

### CONCLUSIONS

The hope that various inorganic elements might be taken up by malignant cells in such vastly greater amounts than by normal cells, that cancer could be effectively treated by administering the radioactive isotopes of these elements to patients has materialized to only an extremely limited extent. Work is now in progress on the selective concentration in cancer cells of a multitude of organic compounds such as amino acids, hormones, and so forth. These organic compounds can be synthesized from radioactive elements. Thus, the search goes on for a therapeutically effective means of selectively irradiating cancer cells without seriously damaging surrounding normal tissues.\*

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# COMPARATIVE THERAPEUTIC EFFECTS OF RADIOACTIVE AND CHEMICAL AGENTS IN NEOPLASTIC DISEASES OF THE HEMOPOIETIC SYSTEM\*

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**R**ADIATION is but one of many agents having specific action on the blood-forming system. The present report will deal briefly with a number of chemical agents which have a measure of effectiveness in the treatment of diseases of this system, and in somewhat greater detail with the action of radioactive phosphorus and the alkylamines.

*Arsenic.* Historically, arsenic appears to be one of the oldest chemotherapeutic agents which has stood the test of time.<sup>14</sup> Forkner<sup>5</sup> considers that arsenic is of chief clinical value in chronic myeloid leukemia given as Fowler's solution in doses of 5 to 10 or more minims daily. It has a positive effect in chronic lymphatic leukemia, but in this disease its effectiveness is generally agreed to be much less than in myeloid leukemia.

The precise mode of action of arsenic in leukemia is uncertain. It is known that arsenic is an agent which arrests cell division, and is an enzyme inhibitor, particularly of enzymes containing the sulfhydryl group. In accordance with current trends in pharmacologic thought and in analogy with other agents which will be discussed, it seems likely that the action of arsenic on enzymes is important in this connection. It is known that arsenic is concentrated in blood cells and in bone marrow, but other organs show equally high concentrations, including bone and skin. In fact, the diagnosis of chronic arsenical poisoning can be made by analysis of hair for arsenic. Arsenic is a mild carcinogenic agent, producing keratoses of the skin after long administration, which may be the precursors of cutaneous carcinoma.

*Benzol.* Another agent with a marked and specific action on hemopoietic tissue, particularly myeloid tissue, is benzol. Because of its importance as an industrial hazard, its toxicity to bone marrow is well known. It may cause aplastic anemia, or it may cause an overcompensation in the form of myeloid metaplasia in extramedullary organs. Myeloid metaplasia can be almost indistinguishable from myeloid leukemia, clinically and hematologically, and indeed pathologists may be doubtful as to the correct diagnosis. As an end result, myeloid leukemia may follow chronic benzol intoxication, and this may bear an analogy to the experimental production of lymphoid leukemia following total body roentgen irradiation.

Benzol is undoubtedly effective in relieving leukemia, but it is not in common use at present in this country. The reasons given for its neglect are that its toxic and effective doses are closer together than in the case of other agents, and particularly that there is great individual variability in response. Certainly, fatal myeloid metaplasia may be seen following relatively minor exposures in susceptible individuals.<sup>18</sup>

*Other Agents.* Certain other agents deserve comment, on behalf of which there is some recent evidence of effectiveness, but which do not recommend themselves for present clinical use. The first of these is adrenal cortical hormone, specifically compound E of Kendall. In accordance with the well known reciprocal relationship between the adrenals and lymphoid tissue,<sup>20</sup> the administration of this compound in very large doses<sup>10</sup> has produced temporary

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regression in mouse lymphoma.

Colchicine is another agent falling in this category. It has both cytotoxic and hemorrhage-producing properties, and has effectively caused regression of certain animal tumors, particularly when implanted under the skin. It was shown by Lits and co-workers<sup>16</sup> to be effective in mouse lymphoma, although regressions were temporary and were succeeded by recurrences of different histopathologic type which were resistant to further treatment. In patients treated with moderate doses (4 milligrams daily by vein) only a transitory reduction in total white blood cell count was observed similar to that seen in normal individuals.<sup>1</sup>

The bacterial polysaccharide from *Serratia marcescens*, which is similar to or identical with the active agent in Coley's mixed toxins, has a deleterious effect on many tumor types, and incidentally on lymphosarcoma. This agent produces very severe systemic reactions and regression of animal tumors associated with hemorrhage and cytotoxic damage. Clinical experience has been relatively disappointing, although regressions of certain human tumors have been observed. Of the first 4 cases of malignant disease treated with this material,<sup>3</sup> one was a patient dying of widely disseminated lymphosarcoma. A single dose of the polysaccharide resulted in an extremely severe toxic reaction (hyperthermia to 107° F. and coma), following which there was virtually complete regression of the tumor masses and relief of other symptoms. After six to eight weeks the tumors recurred and were then resistant to further injections of polysaccharide.

In the case of the three agents mentioned above, the available experimental or clinical evidence suggests that such favorable responses as occur cannot be reproduced, since resistance to their effects is induced almost at once.

*Urethane (Ethyl Carbamate)*. Recent reports indicate that this substance may be effective in causing a reduction in the leukocyte count and considerable palliative effect in human and mouse leukemia.<sup>4,9,17</sup>

It has also been partially effective in mammary and prostatic carcinoma.<sup>11,17</sup> It is probably too early to judge the possible usefulness of urethane. The same may be said for stilbamidine, which has been shown to exert a specific action on the malignant plasma cells in multiple myeloma.<sup>21,22</sup>

*Radioactive Isotopes*. In view of the radiosensitivity of the lymphomas and leukemias, and of the prolonged relief seen in polycythemia rubra vera following total body irradiation, it was natural to anticipate that radioactive isotopes would be of value in these diseases.

Let us consider the characteristics of an isotope which would determine its clinical usefulness. First, it must have an appropriate half-life. Certain isotopes have an extremely short half-life, so that it may be difficult or impossible to remove them from the pile or cyclotron with sufficient activity. Others, with a long half-life and a propensity for deposition in bone or some other organ susceptible to carcinogenesis, will ultimately become very dangerous. There is ample experience to indicate that this is true of radium, and experimental studies have shown that radioactive strontium, plutonium, and other radioactive elements will fall into the same class.<sup>2</sup>

Localization of radiation in the body also conditions the value of an isotope. This is determined by the actual localization of the isotope, and by the range of its radiations. Thus, to cite extreme examples, sodium<sup>24</sup>, which has an almost uniform distribution throughout the extracellular compartment and an energetic gamma emission, irradiates the body in a manner very similar to that of high voltage total body roentgen radiation. Plutonium, on the other hand, with very discrete tissue localization and a short-range alpha ray, distributes its radiation in a highly non-uniform pattern resulting in extreme exposure of certain cells, relative to the total radiation received by the body.<sup>2</sup>

Radioactive phosphorus (P<sup>32</sup>) is intermediate between these two in respect to its tissue distribution, since its range is of



the order of 1 millimeter in tissue and it localizes somewhat selectively in bone, hemopoietic and proliferating tissue. Its half-life is 14.6 days. For these reasons it should be expected to irradiate the entire body, but to deliver relatively more ionizing energy to bone marrow, lymphoid tissue, and leukemic cells.<sup>15</sup> Its half-life is not inconveniently short, nor so long as to render chronic irradiation effects a serious hazard.

The literature on  $P^{32}$  treatment of blood dyscrasias has been reviewed elsewhere.<sup>13</sup> In summary, it has proved extremely valuable in chronic leukemias and usually in lymphosarcomas, of variable usefulness in Hodgkin's disease, and useless in acute leukemias and multiple myeloma. Obviously, its value in Hodgkin's disease may depend on whether the cells of a particular tumor type have a high affinity for  $P^{32}$ .

In addition,  $P^{32}$  is very valuable in the treatment of polycythemia rubra vera, and has been considered by several investigators to be the treatment of choice in this disease.<sup>13</sup>

*Mode of Treatment with Radioactive Phosphorus.* The isotope may be given by mouth or by intravenous injection. If given by mouth, care should be taken to promote absorption by administering it two hours before breakfast, and by avoidance during the period of treatment of iron compounds, alumina, milk, and other agents which might hinder the absorption of phosphate. With these precautions, it is usual to assume 75 per cent absorption. Dosage by mouth is therefore one-third greater than by the intravenous route.

Because of body distribution of the radiation, hematologic effects are marked and can be studied by examination of the peripheral blood, which enables one to control treatment. Dosage can be regulated accordingly, although due caution must be used as in the administration of total body roentgen irradiation. In the clinic at the University of Chicago, it has been customary to treat lymphomas and leukemias by the administration of small doses (circa 1 millicurie) once to twice weekly over varying periods, depending upon the response.

Polycythemia rubra vera has been treated by a single intravenous administration of 6 to 8 millicuries. As in roentgen therapy, further treatment is determined by the time of recurrence of disease.

It can be calculated that a dose of 6 millicuries to a man of average size (0.1 mc. per kilogram) would, if all retained, deliver in the first day the equivalent of approximately 3 roentgens of total body radiation. Assuming loss of less than 50 per cent by excretion, the total dose would be between 30 and 60 r. Because of the selective distribution of the isotope, the amount of radiation to blood-forming tissues would be somewhat greater.

*Nitrogen Mustards.* Work done during the war<sup>7</sup> has shown a remarkable parallelism between the effects of these compounds and those of ionizing radiation. One sees destruction of rapidly growing cells and specific damage to hemopoietic tissue. The nitrogen mustards have even been shown to cause genetic mutations and to have a specific inhibitory effect on sulfhydryl enzymes resembling the effects of radiation.<sup>19</sup>

Stimulated by the observed effects of these chemical compounds on the blood-forming tissues, clinical studies initiated by Gilman *et al.*<sup>8</sup> and Jacobson *et al.*<sup>12</sup> have served to add this group to the armamentarium of therapeutic agents in neoplastic and allied hemopoietic diseases. Two nitrogen mustards—methyl-bis(beta-chloroethyl)amine hydrochloride and tris(beta-chloroethyl)amine hydrochloride—have thus far been given intensive clinical evaluation. These analogous compounds are unstable in aqueous solution and their physiologic action is ascribed to the first transformation product, in which an immonium is formed.<sup>7</sup>

The nitrogen mustards are administered intravenously soon (within five minutes) after they are dissolved in saline solution, by injection into a saline intravenous system already in operation. Thus, thrombosis due to the irritant action of the agent can be avoided, and the substance is introduced before it undergoes chemical changes beyond the production of the effective deri-

vative. In the clinic at the University of Chicago, 0.1 milligram per kilogram of body weight has been given daily over a four to six day period.

*Toxic Reactions.* The most immediate reaction is nausea and vomiting. This occurs within a few hours after administration and abates three to four hours later. There is considerable variation in the intensity of the reaction, as is true in the case of roentgen sickness. Local thrombosis or phlebitis may be seen at the injection site if the solution has been insufficiently diluted. Severe depression of hemopoietic tissue occurs in both bone marrow and lymphatic tissue, but (unlike, for example, that following benzol) is invariably followed by regeneration.

*Therapeutic Results.* As with radioactive phosphorus, the nitrogen mustards are ineffective when given in acute lymphatic or acute myelogenous leukemia, or in multiple myeloma. Encouraging results have been seen in chronic lymphatic and myelogenous leukemia, lymphosarcoma, and Hodgkin's disease. In addition, 2 cases of sympatheticoblastoma showed marked, though temporary, remissions. Among the chronic leukemias and lymphomas, probably the least satisfactory series of results have been in the chronic myeloid group.

As with radiation therapy of various types, one sees a great diversity of response between patients. It seems clear, however, that the nitrogen mustards have an effect which is often spectacular in terms of disappearance or reduction in size of tumors, especially of lymphatic tissue, and in alleviation of symptoms. It seems equally true that remissions in general, although more complete in the symptomatic sense, are probably shorter than those following roentgen treatment. Similar to roentgen treatment, the nitrogen mustards produce repeated remissions with successive courses of administration, but resistance to treatment eventually develops.

It is noteworthy and encouraging, that certain patients with Hodgkin's disease and lymphosarcoma which have become radiation resistant through protracted roentgen

treatment, have undergone remissions, sometimes repeatedly, during subsequent nitrogen mustard therapy. Four such cases have been detailed.<sup>12</sup>

In polycythemia rubra vera, results of nitrogen mustard therapy have been favorable as far as can be ascertained at the present time. Because of the long remissions seen in this disease following various other forms of therapy, a proper assay of therapeutic results must necessarily await further experience.

#### DISCUSSION

Before attempting to assay the comparative value of different agents in the therapy of this group of diseases, it may be well to discuss certain criteria whereby we may attempt to measure them.

The first criterion is localization. On this score roentgen therapy appears to lead the field in the treatment of localized lymphosarcoma, reticulum cell sarcoma, and Hodgkin's disease. There is considerable evidence also, of course, indicating that radical local surgery has an important part in the treatment of these specialized situations.<sup>6</sup> Where this is inexpedient, it would appear that a localized lesion can successfully be treated, at least for the purpose of producing a remission, by an amount of roentgen radiation (1,000 or 2,000 roentgens) which could not be tolerated by the whole body. Such localization of the agent to a given segment of the body would not seem possible with such chemotherapeutic agents as the nitrogen mustards.

Another type of localization is that attained by use of the radioactive isotopes. Here we can visualize a situation in which a certain isotope might, by virtue of its chemical or metabolic properties, localize only in those tissues requiring irradiation. In combination with a soft, short range radiation, an ideal set of conditions would be realized. Unfortunately, there is no isotope available for treatment of hemopoietic diseases analogous to radioactive iodine in treatment of the hyperplastic thyroid, where virtually all of the radiation is delivered to the tissue in question. Even if

there were such an isotope with highly specific hemopoietic tissue localization, the radiosensitivity of the normal blood-forming cells would probably limit its value to an extent not encountered in the case of most other tissues.

As we have shown, by virtue of its concentration pattern, radioactive phosphorus is theoretically superior to total body roentgen irradiation in the treatment of polycythemia rubra vera and the leukemias, and also in lymphosarcomas; yet its usefulness is much less in Hodgkin's disease and other tumors which may have no particular tendency to concentrate phosphorus. Little is, of course, known about the localization of most of the chemical agents in neoplastic tissues, although this is probably of equal importance. Colchicine has been found not to concentrate in tumors of mice which are sensitive to it.<sup>1</sup>

A second criterion is the nature of the remission. It seems true that we have no agent which will permanently sterilize leukemia or disseminated lymphoma. All that it is possible to say is that the general nature of remissions after generalized and local radiation and after the use of the nitrogen mustards appear qualitatively similar, with the quantitative differences noted above.

Third, we must consider phenomena such as radiation resistance. It is not our purpose to discuss whether this is due to cell selection, to vascular changes, to gradual impairment of normal hemopoietic function, or to other causes. This only too familiar condition has its parallel in the acquired resistance to nitrogens mustards, and to the other chemical agents for which we have presented clinical or experimental data.

Finally, we need to understand whether the modes of action of agents are different; and hence, whether a second agent may be useful after resistance has developed to a first agent. There is some evidence to suggest that nitrogen mustards may be useful after roentgen-ray resistance has become obvious to the radiologist. It is most important that more information be gained

on this point, since, if it is a general truth, combinations of various forms of treatment might represent a considerable advance in therapy. It may be worth while to remember that parallel information about other agents is scanty or lacking.

Thus, although the radioactive and chemotherapeutic agents discussed here may not at the moment show promise of creating a new era, there is still much important work to be done. The nitrogen mustards which have been put to use are only isolated examples of potentially hundreds of analogous drugs which, through different cell localization or diminished toxicity, might prove more effective. The possibility of sensitizing tissue to the action of these agents must also be sought, as well as pharmacologic means of allaying side-effects.

#### CONCLUSION

A new field is rapidly being opened, both in the use of isotopes and in chemotherapy, which for its growth will require the best we have in clinical observation and in experimental techniques. We may look forward to great efforts on the part of chemists to derive compounds which have effectiveness out of proportion to their toxicity; and on the part of pharmacologists and physiologists to seek the mechanisms responsible for different modes of action and to derive means of allaying side-effects. On behalf of this goal, and in view of the menace of future atomic warfare as well, it will behoove radiologists to pay increasing attention to the hitherto minor problem of radiation sickness, and to the little understood phenomenon of radiation resistance.

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#### DISCUSSION OF SYMPOSIUM ON RADIOACTIVE ISOTOPES\*

DR. G. FAILLA, New York, N. Y. This has been a most interesting symposium and I think every speaker should be congratulated for the excellent presentation of the subject he was discussing. In particular, it is rather fine to see that the speakers did not speculate on what can be done with radioactive isotopes in an abstract way but gave us the results of work which has already been done and which has been carefully done.

The publicity we have had about atomic energy has been made up of many speeches indicating in a vague way the great future of radioactive isotopes and how many different things can be done with them. In this Society we want to know exactly what is being done and what has been done, that is much more valuable than any speculation.

As radiologists, a very great opportunity is opening up for all of you, if you take full advantage of it. In order to do this, you will have to study about radioactive isotopes, and you will have to know much more about physiology and the effects of radiation on different tissues than has been necessary in the past.

The complications in the use of radioactive isotopes as therapeutic agents are much greater than in the use of roentgen rays. However radioactive isotopes are here, and will be used and radiologists are the ones that should take the lead in doing this work and doing it safely.

The radiologist is in an excellent position to do that, whereas if we allow others to come into the field who haven't had the background of radiation effects and dangers, there may be a great deal of harm done. That is one of the things that we should emphasize. Great caution has to be exercised because there are dangers to the individual handling the radioactive isotopes

\* Papers by Drs. Quimby; Evans; Reinhard; and Brues and Jacobson.

and to the patient, if the proper care is not exercised in the administration of these new agents.

One of the things that is most important is to know where the isotope is going to be deposited in the body, where it is likely to concentrate, because such concentration will be the limiting factor in the dose that can be administered. The material may be rather uniformly distributed throughout the whole body or it may be localized in some particular organ. This information must be known before one can decide how large a dose can be given. Unfortunately, in the treatment of cancer one has to use large tissue doses, as you all know.

In general, one is limited in the application of a therapeutic dose by the tolerance of normal tissues. You have the same trouble with radioactive isotopes. If you know how to protect the patient from the injurious effects of roentgen rays and radium and the limitations of their use, you can carry this knowledge over into the field of isotope therapy and you won't injure anybody—provided, of course, that you know the distribution of the isotope in the body.

Another thing that has been mentioned this afternoon is the question of measurements. There are discrepancies from one laboratory to another. However, these difficulties will be ironed out in the near future. In any case, I would suggest that if you undertake the use of radioactive isotopes you get in contact with a university laboratory in your vicinity where Geiger counters and other measuring devices are available, and get somebody familiar with these instruments to cooperate with you and measure your radioactive isotopes every time before you administer them. The measurements may not be in accord with all the other laboratories, but as far as you are concerned, the main thing is to be able to duplicate your own doses from time to time. In the beginning you will be feeling your way and will start with a low dose; after you have acquired a certain experience, you will probably want to increase that dose. If you know it in terms of your own standard, and your own apparatus, you will be safe, but if you use unchecked measurements made by somebody else, they may vary by a considerable factor and you may do harm.

The physicists will solve the problem of measurements in a much shorter time than the biologist will give you the information about the distribution of isotopes in the body, with respect to the different organs and cellular components, and with respect to time following ad-

ministration. If you can make your own measurements or get somebody that you know and trust to make them, you can duplicate your treatments with assurance, irrespective of the value of the millicurie or anything else.

Mention has been made about radioactive phosphorus having an ideal half-life for the treatment of leukemia or other therapeutic purposes. I should like to point out that radioactive sodium is probably just as effective in the treatment of leukemia, and that its shorter half-life is advantageous. I think the half-life of phosphorus is perhaps a little too long. If retained in the body  $P^{32}$  will produce effects for a considerable period of time, and if by any chance one has administered too much, there is no way of getting it out quickly. On the other hand, if you use radioactive sodium, which has a relatively short half-life of fifteen hours, you can control the dosage better. Some work that has been done with radioactive sodium at Columbia University in the treatment of leukemia indicates that it is equally as effective as phosphorus for that purpose (or equally as effective as roentgen rays).

All leukemia cases, unfortunately, eventually become resistant to any form of treatment and die. That seems to be the case with any one of the agents which has been mentioned today or any agent that has been used in the past. I should like to see some experimental work done to determine why these leukemias become resistant to all sorts of treatment after a certain period of time. Then maybe we can find a real cure for that disease, but that will take time.

As for the dangers to the operator, I think those of you who have used radium, particularly, should know how to protect yourselves from these radioactive isotopes. In any case, one should not expose himself to these radiations for any longer time than is absolutely necessary. Long forceps or long handled devices should be used. Lead screens and protective enclosures should be provided. The objective should be to prevent local overexposure as well as general exposure of the whole body. I am afraid that there will be accidents in spite of all precautions taken, and the more careful you are the better.

DR. L. O. JACOBSON, Chicago, Illinois. In general the remissions produced by the nitrogen mustards are not comparable to those produced by roentgen rays. That is, they are shorter. We have, as Dr. Brues pointed out, treated some patients referred to us by other people as

well as patients from our own clinic who were roentgen-ray resistant. Remissions had been negligible or very brief from roentgen irradiation and we have produced remissions of six months and more with mustards on repeated occasions.

I also want to say a word about the toxicity of radiations or chemical substances in the treatment of these dyscrasias. We are frequently too alarmed by the leukopenias that occur after such treatment. I don't want to leave the impression here today, however, that we should pay no attention to the development of leukopenia, but in the past four years in which we have used the nitrogen mustards, we have seen many leukopenias below a thousand on many occasions without any untoward effects. In one case an erysipelas developed. The erysipelas was treated satisfactorily with penicillin.

Maybe we have been lucky, and the next ten cases will get infection if we do treat with doses of nitrogen mustard large enough to produce severe leukopenias. This seems unlikely in our experience.

As far as penetrating radiations and radioactive materials are concerned, experience on the Plutonium Project tends to indicate that the leukopenia is only one manifestation of pathological effects and per se is probably not the most serious.

The question has come up during the treatment of patients with the nitrogen mustards, whether or not one might be able to double the dose? For example, of a dose of 25 milligrams of mustard produces a leukopenia of less than a thousand, could you give 50 milligrams and therefore get more effective remissions? We have tried this but as yet have no good evidence that remissions thus produced are longer or more complete.

I want to bring up one question for Dr. Reinhard, Dr. Evans, and others. Polycythemia has been treated in the past with cathode roentgen rays, with  $P^{32}$ , and now lately with mustard. Our results with the mustards have been quite interesting. We still have, after a period of from six months to twenty-four months, 6 patients in remission that were treated with the nitrogen mustards. With roentgen therapy, remissions in our experience, at least, have been relatively short. The remission is longer with the  $P^{32}$  than it is with roentgen rays even though the degree of effect on the peripheral blood and the bone marrow are comparable in terms of the leukopenia, and so forth. Is this due to the fact that

the half-life of phosphorus is 14.3 days and therefore the effect is over a longer period? Or is it due to some other mechanism?

DR. PAUL S. HENSHAW, Oak Ridge, Tenn. We have heard this afternoon a series of very interesting and stimulating papers dealing with radioactive isotopes. We have heard of both the successful attempts, to use these new agents, and of unsuccessful attempts.

Since no issues have been raised, however, with which I am competent to deal, I will not attempt to discuss any of the papers. However, since I am now associated with the radiobiologic work at Oak Ridge, perhaps it would be in order to mention very briefly something about the availability of isotopes.

Dr. Paul Aebersold, whom you know, and who is at this meeting today, is in charge of the distribution of isotopes from Oak Ridge. He has associated with him an advisory staff and a group of associates to carry on the work. It is not my purpose to speak for him, but perhaps I am in a position better than he to say that this group has spent a great deal of time in making preparations for the distribution of isotopes.

It was necessary for them, first of all, to arrange a catalogue of available materials and the amounts. Next it was necessary to find feasible ways of shipping these materials. It was necessary also to arrange to separate the isotope work from the atomic bomb work, so that the secrecy provisions were not an obstacle in distribution.

Perhaps the greatest service that this group is now able to render is that of advising prospective users of such materials as to whether it will be possible or feasible to undertake the work they have in mind. This staff will examine the proposals and ask questions as to whether proper detecting and measuring instruments are available, whether proper protective measures are in use and so on.

They will even inquire as to whether the proposed problem has been properly conceived and they will make suggestions as to the prospects of getting answers to the questions raised.

I think I may say for Dr. Aebersold that he will be glad to receive requests for information or requests for the use of isotopes at any time from any of you.

DR. H. J. ULLMANN, Santa Barbara, California. Dr. Jacobson spoke of radiation sickness occurring during the treatment of leukemias with the roentgen ray. I believe it entirely un-

necessary to produce roentgen sickness, and that it only occurs with gross overdosage. I can see no valid reason for such large doses when one can get satisfactory remissions with a dose of 50 to 100 r measured on the skin. I treat once a day but not until I have the white count, taken shortly before treatment. This daily dose is continued until there is a daily progressive fall in the total white count. It is then discontinued until the count ceases to fall. Some patients will go along with a falling count for several weeks after the last treatment and obviously should have no further irradiation. Treatment is not resumed unless the fall stops before a satisfactory count is reached or begins to rise. But treatment is never based on count alone. All clinical factors must be taken into consideration. No roentgen sickness is ever produced by this method. I brought this up to get it on the record, because I have heard "roentgen sickness" employed so much as an argument against the use of the roentgen ray in the treatment of the leukemias. The production of roentgen sickness is absolutely unnecessary.

DR. G. FAILLA, New York, N. Y. I would like to ask Dr. Brues and Dr. Jacobson whether they have used the two agents in combination—the phosphorus and mustards?

DR. L. O. JACOBSON, Chicago, Illinois. We have studied some of these patients with repeated courses of nitrogen mustards for long enough periods to give us a fair approximation of the expected remission. We have alternated mustard treatment with roentgen therapy. We have combined mustard therapy with roentgen therapy. In general, alternating nitrogen mustards with roentgen therapy does not seem to be any more effective than treatment with one or the other alone. We have combined mustard therapy with simultaneous therapeutic doses of  $P^{32}$ . This procedure failed to produce longer or more satisfactory remissions. On the other hand, treatment with nitrogen mustard and simultaneous treatment with roentgen therapy has proved to be quite effective. This latter procedure combines general therapy with local therapy.

DR. EVANS (closing). I would like to emphasize that the local concentration  $C$  may vary from point to point in a tissue mass. Then the local dosage will vary in proportion. If the aver-

age range in tissue of the particular beta rays involved is  $l$ , then  $C$  is to be interpreted as the local concentration in volume elements of the order of  $l^3$ . This will amount to 1 or a few cubic millimeters in most cases. The dosage throughout a large tissue mass can be taken as uniform only if it is known that the concentration of the isotope per mm.<sup>3</sup> is substantially constant throughout the tissue mass.

DR. REINHARD (closing). Dr. Jacobson raised the question as to why remissions obtained in polycythemia with radioactive phosphorus are longer than with roentgen irradiation. I don't know whether they are longer or not. I am not sure that there are sufficient data now available to determine whether or not remission with radioactive phosphorus is longer than remission obtained from roentgen irradiation.

I think probably if the remissions are longer, one reason may be that at first the correct dosage of radioactive phosphorus was not known. We have been using this agent for a relatively few years and certainly a good many patients who received radioactive phosphorus were overtreated. If you give enough radioactive phosphorus to push the erythrocyte count down to 3,000,000, certainly the remission is going to last a little longer than if you give just enough to bring it down to 5,000,000. If you were to give comparable amounts of radioactive phosphorus and roentgen rays in terms of radiation delivered to the bone marrow to two groups of patients with polycythemia, I doubt whether there would be any difference in the duration of remission.

Dr. Ullmann raised the question of radiation sickness. I made that statement and not Dr. Jacobson. I think if I may quote the statement, no one can object to it. I made the statement that freedom from radiation sickness is one *possible* advantage of radioactive phosphorus.

I am aware that there are methods of giving roentgen therapy which obviate the difficulty of radiation sickness. However, as roentgen therapy is ordinarily given, radiation sickness is sometimes seen. I was merely trying to emphasize the fact that radiophosphorus gives the ultimate in low grade radiation over a long period of time.

There is no practical means of giving roentgen therapy in such a manner as to obtain very low grade radiation continually over a period of days or weeks.



# ANALYSIS OF TECHNICAL FACTORS AND RESULTS OF TREATMENT IN CARCINOMA OF THE CERVIX UTERI

## DESCRIPTION OF IMPROVED RADIUM APPLICATOR

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SEVERAL recent writers on the subject of the treatment of carcinoma of the cervix uteri have expressed the opinion that radiotherapy is now static, that little more may be expected from it and have suggested as an alternative a return to surgical methods at least for certain selected cases. In a paper by Meigs<sup>2</sup> on this subject the statement is made that "the treatment of cancer of the cervix by radiation is at a standstill", and he quotes with approval a paragraph from Miller of the University of Michigan Hospital as follows:

The limitations of existing methods of treatment are well recognized. No one expects the impossible, but there is good reason to believe that therapy is disappointing. We appear to have reached that comfortable state wherein we hesitate to disturb the efficiency of a therapeutic system which has taken a long time to establish. Perhaps the ease of administration, as well as the apparent effectiveness of irradiation therapy, has lulled us into a state of inertia, in which we fail to exploit existing methods of treatment to their fullest capacity. In radical abdominal hysterectomy, as first performed by W. A. Freund in 1878, and later popularized by Wertheim, was recognized a potent weapon for combatting cervix cancer. But because of its high primary operative mortality rate, and its restricted field of usefulness, the operation was permitted to pass into the discard. Radium and X-ray have also proved their worth. Yet, after almost a quarter century devoted to the refinement of technic and stabilization of procedure, I find there is little to boast about. . . . Perhaps we have reached the end of an era.

These and other somewhat similar statements are sufficiently challenging to cause us to carefully review the whole subject

and to inquire whether this pessimistic outlook is justified by the facts. The present paper will, therefore, be devoted to an inquiry into three questions:

- (1) How do the best results obtainable by surgery compare with the best results by radiotherapy?
- (2) Is progress still being made in radiotherapy or is it a fact that the latter is "at a standstill"?
- (3) Can further improvements be expected in radiotherapy in the future?

(1) *Comparison with Results by Surgery.*

It has been stated by many writers that it is difficult and inaccurate to compare the results of treatment by surgical methods with those obtained by radiotherapy. And yet no very convincing reasons are brought forth in defense of this position. The work of Bonney in England and of Taussig in America are commonly cited as examples of the best results obtainable by radical surgery. Bonney<sup>1</sup> operated upon 500 patients out of a total of approximately 900 actually diagnosed as cancer of the cervix. His five year cure rate is stated to have been 40 per cent for those in whom no glandular extension had occurred and 22 per cent for those in whom lymph node involvement was present—in other words, 40 per cent for those cases which now would be classified as Stage I and II; 22 per cent for operable Stage III. All Stage IV and the majority of Stage III cases were excluded since they were considered inoperable and do not appear in the statistical report. Thus the five year figures refer strictly to patients operated upon, not to the percentage of all cases seen as is the general rule in radiological reports. If the figures

\* Presented at the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.



quoted took into consideration all cases diagnosed as cancer as well as those operated upon, it is clear that the five year survival rate quoted would need to be substantially reduced and would be closer to 25 per cent for the first group and 15 per cent for the second. Taussig is reported to have operated upon 70 patients in Stage II with a five year survival rate of 37 per cent.

So far as actual "cure" by surgery is concerned it may be assumed that these figures represent, if not the best attainable,

(23 per cent) certainly does not represent the results at present being obtained in modern radiotherapy clinics, and in the interests of an accurate estimate it is important that this fact be taken into consideration. Many such series of figures are available in the literature. The figures used in the present paper for illustration are taken from the recently issued report from Manchester shows five year net survivals (for the year 1938) as follows: Stage I, 71 per cent; Stage II, 52 per cent; Stage III,

TABLE I  
CARCINOMA OF THE CERVIX UTERI, 1929-1940  
(Gross survivals—no deductions)

Stage	Number of Cases	Living at end of—		
		3 years per cent	5 years per cent	10 years per cent
I	92	80.8	74.0	50.5
II	277	62.5	50.5	29.03
III	335	33.5	26.8	13.6
Total I, II and III	704	51.3	42.5	26.25
Stage IV	158	11.4	4.9	0
Total—all Stages	862	43.9	35.6	21.9

at any rate the best that have been attained up to the present. For comparison with radiotherapy it is important that they be compared with work of an equally high standard representing modern techniques, whereas quite frequently when such a comparison is undertaken by a surgeon figures are selected which do not at all represent the best that radiotherapy can be expected to accomplish. For example, in the paper already quoted, speaking of Taussig's operative results, Meigs says: "Of 70 patients in Class II of the League of Nations Classification 37 per cent were living and well after five years. In a parallel group of 118 patients treated by radiation alone the five year salvage was only 23 per cent." It we are to understand a "parallel group" to mean Stage II of the League of Nations classification the figure quoted

37 per cent. Thus, the average of Stages I and II which may be compared with Bonney's cases without lymph node invasion is 61 per cent against Bonney's 40 per cent; and those in Stage III with lymph node involvement 37 per cent against Bonney's 22 per cent. Taussig's figure of 37 per cent would have to be compared with the Manchester figure for Stage II of 52 per cent. I do not see how one can escape the conclusion that this comparison is fair and accurate. Furthermore, these facts refute the statement that radiotherapy is incapable of controlling lymph node invasion since this type of invasion must necessarily be present in all Stage III cases in which, as has been shown, the five year survivals amounted to 37 per cent.

*Results in this Institute.* Since 1929 we have treated in this Institute 1,142 cases of

cancer of the cervix of which three year figures are available in 862 and five year figures in 669 and ten year survivals in 333 cases. These results are shown in Table I indicating that results of the order of those quoted from Manchester are not unusual and are no doubt being obtained in most well organized radiotherapy centers.

Thus the first conclusion to be reached is that radiotherapy is still superior to surgery by a substantial margin in those cases in which surgery is possible and has a very useful place in many cases in which surgery is quite impossible. In 57 cases

(2) The second question in which we are interested is whether "the treatment of cancer of the cervix by radiation is at a standstill".

A correct answer to this question should be equally interesting to gynecological surgeons and to radiotherapists and is certainly vital to the patient.

Table III includes a tabulation quoted in full from Meigs' article partly because it is an excellent compilation of figures from nine large clinics, both in Europe and America, but also because most readers will recognize the figures as being about

TABLE II  
CARCINOMA OF THE CERVIX UTERI  
Comparison of Results by Surgery and Radiotherapy

SURGERY	Stage I and II		Stage III		
	No. cases	5 year per cent	No. cases	5 year per cent	
	Bonney	500	40		22
	Taussig	70	37		
RADIOTHERAPY	Average of 9 clinics	2233	45.7	2417	21.2
	Manchester 1934-38	340	53.5	241	27.0
	1938 only	70	61.0	53	37.0
	Toronto 1929-40	289	62.2	257	26.8

operated upon by Meigs, injury to the ureters occurred in 10 per cent. One may be quite certain that if any such percentage of serious injuries occurred as a result of radiation therapy the method would be roundly condemned by nearly all surgeons. No one will criticize Meigs and a few other surgeons of like caliber in making an effort to equal or better Bonney's work. But it would be a definitely retrograde step if throughout the country the teaching were adopted that cancer of the cervix should again be treated surgically. There are too few Bonneys and Taussigs for such a procedure to have any other result except a general reduction in the cure rate now being secured in this type of cancer.

fifteen years old and therefore as forming a suitable group for comparison with more recent work. Below Table III have been added more recent figures from several centers representing present methods and results. On this basis, it is apparent that quite substantial progress has been made in all groups except Stage IV. That an equally substantial improvement in the general average has not occurred may be explained by the fact that there is a widespread tendency to refer late cases to radiotherapy centers for the purpose of receiving palliative treatment and nursing care and the statistical tables are heavily and unfavorably weighted with such cases as a result. It is apparent, in spite of this, that defi-

nately favorable progress has been made. The figures quoted would indicate an improvement up to 1938-1940 of the order of 20 per cent in Stage I, 15 per cent in Stage II, 5-6 per cent in Stage III and little or no change in Stage IV.

(3) By far the most important question to the radiotherapist, however, is the last, namely—Can further improvements be looked for in the future, or have we, as Miller suggested, reached the end of an era? We believe that answer is in the affirmative and that such improvements are

both experimental and clinical, to permit us to apply the basic physical principles to the problem of cervical carcinoma far more accurately than at any time heretofore. The essential factors may be recapitulated as follows: A satisfactory technique must be one which delivers a lethal dose throughout the cervical and pericervical tissues and if possible, to the side wall of the pelvis. This lethal dose must be so distributed and timed as to avoid injury to small intestine, bladder, rectum, ureters or sigmoid. Calculations of "tumor doses" to be acceptable

TABLE III

ANALYSIS OF RESULTS OF TREATMENT FOR CARCINOMA OF THE CERVIX

Institution	Stage I		Stage II		Stage III		Stage IV		All Stages	
	No. of Cases	Per Cent Cured	No. of Cases	Per Cent Cured	No. of Cases	Per Cent Cured	No. of Cases	Per Cent Cured	No. of Cases	Per Cent Cured
Memorial Hospital (New York City)	17	52.9	15	46.7	74	18.9	30	10.0	136	24.3
Women's Hospital (New York City)	9	55.5	24	25.0	18	16.7			51	27.3
University of Brussels (Brussels)	6	33.3	20	40.0	28	14.3	9	0.0	63	22.2
Liverpool Radium Institute (Liverpool)	8	62.5	28	25.0	43	14.0	15	0.0	94	19.1
Marie Curie Institute (Paris)	9	66.6	20	60.0	75	20.7	22	4.5	126	33.3
Radium Center (London)	4	25.0	27	11.1	37	18.9	19	0.0	87	12.6
Institut du Cancer (Paris)	9	44.4	15	53.3	40	35.0	19	10.5	83	33.7
Institut du Radium (Paris)	12	66.6	44	43.2	34	32.3	12	8.3	102	38.2
Radiumhemmet (Stockholm)	31	48.4	67	26.9	71	8.5	42	9.5	211	20.4
All reporting hospitals	607	55.2	1,626	36.3	2,417	21.2	1,020	5.3	5,670	26.3
Recent Figures										
Marie Curie Hospital (London)—1945 Report	88	76.1	377	58.6	734	29.4	211	7.6	1,410	36.9
Manchester—1945 Report (1934-1938)	48	65.0	292	42.0	241	27.0	245	6.0	826	28.0
Toronto—1945 Report (1929-1940)	73	74.0	216	50.5	257	26.8	123	4.9	669	35.6

to be found in three directions: (1) by a more careful application of physical principles and dosage factors now well understood; (2) by an improvement in the technical details of applying radium and its more skillful combination with roentgen therapy since in all cases except a relatively few both methods are essential, and (3) in the full utilization of the newer radioactive materials which will shortly be available and which give at least the promise of solving the problem of providing adequate dosage throughout all parts of the pelvis.

*Physical Principles Underlying Treatment.* Sufficient work has now been done,

according to present-day standards must be much more accurate and precise than can be expressed by simply stating the dosage delivered to each skin portal.

Tod and Meredith<sup>5</sup> called attention in 1938 to the fact that the most sensitive area in the pelvis is the point at which the uterine artery crosses the ureter since at this point there is located a lymph node (the obturator node) and excessive doses here will result in injury to the ureter which may produce strictures of various degrees of seriousness. They therefore called this critical area Point A and described it as lying 2 cm. lateral to the internal cervical

orifice and 2 cm. anterior to the plane of the cervix. They also described a point 5 cm. lateral to the midline of the cervical canal as Point B, and Neary<sup>3</sup> has indicated the rectovaginal septum as Point S. According to their technique dosage delivered at Point A should not exceed 7,500 r and at Point S must not exceed 5,000 r.

Several years ago we adopted these general principles and have slightly modified them in the following manner:

In order to accurately plot the dosage for the individual patient a roentgenogram of the pelvis is taken as in obstetrical pelvimetry and from this roentgenogram accurate measurements are made. A contour drawing of the patient is then prepared in the conventional manner corrected by means of calipers and transferred to tracing paper. On this contour drawing a tracing of the bony pelvis is made using the measurements obtained from the roentgenogram which tracing now represents an outline of the patient's pelvis with an accuracy of  $\pm 0.5$  cm. From prepared transparencies the position of the uterus and vaginal vault are added to the tracing and Points A, B and S established. The tracing now permits one additional point to be determined, namely the true position of the wall of the pelvis and this we have designated Point C. The above points are clearly shown in Figure 1. For full discussion of the physical factors involved the reader is referred to Neary's excellent article on this subject.<sup>3</sup>

Since most of the lymph nodes in the pelvis lie close to the pelvic wall it is essential that a dose lethal for carcinoma be delivered at Point C and this dose should be 5,000 r or higher. Numerous studies by many workers have demonstrated that this is not possible by means of radium alone in the form commonly employed and not possible by roentgen therapy alone, short of excessive skin doses. The problem is, however, capable of solution by a combination of both, and a satisfactory technique should be one, in our opinion, which provides for the most effective possible combination of these two forms of radiation since we are

concerned with "radiation" therapy in the broad sense and not with either "roentgen" or "radium" therapy as such.

The first question which arises is: "Which is the most desirable order?" We believe there are numerous reasons why roentgen therapy should precede radium:

1. At the end of a course of roentgen therapy the bulky tumor originally present will usually have either completely disappeared or at least will have undergone very marked regression, ulceration will have healed and with it secondary infection will have disappeared, thus greatly simplifying the application of radium and reducing its dangers. In a previous publication from this Institute<sup>4</sup> it has been reported that prior to the introduction of preliminary roentgen therapy 12 per cent of all mortality and 16 per cent of all morbidity were due to the presence of infection. Since the use of preliminary roentgen therapy the complications due to infection have been greatly reduced and with the introduction of penicillin and the sulfonamides this no longer presents a serious problem.

2. The preliminary roentgen series is a very good therapeutic test for radiosensitivity of the particular neoplasm with which one is confronted. If no improvement is secured following an adequate roentgen series the tumor is usually highly resistant and will require the highest possible dosage or may indeed be incurable by radiotherapy.

We are therefore of the opinion that the roentgen series should precede radium in all cases except Stage I and certain Stage II cases in which there is no serious objection to completing the radium series first.

*Roentgen Therapy.* In patients who weigh only 110-115 pounds it probably does not greatly matter whether this treatment is carried out at 200 kv. or higher, but above 115 pounds and certainly above 125 pounds there is no doubt that a great advantage is derived from the use of higher voltages. In our Institute this treatment is carried out at 400 kv., using a distance of 100 cm. and a filter equivalent to 6 mm. Cu. The half-

value layer is 4.5 mm. Cu, and the depth dose at 10 cm. 37 per cent.

A very few cases in which calculations are made using four, five or six portals provide convincing evidence that six portals are almost essential for adequate

rotation, one portal per day. The posterior portals are directed obliquely leaving a wide central space so as to avoid the rectum.

By referring to Table IV it will be seen that in a patient weighing 135 pounds, if

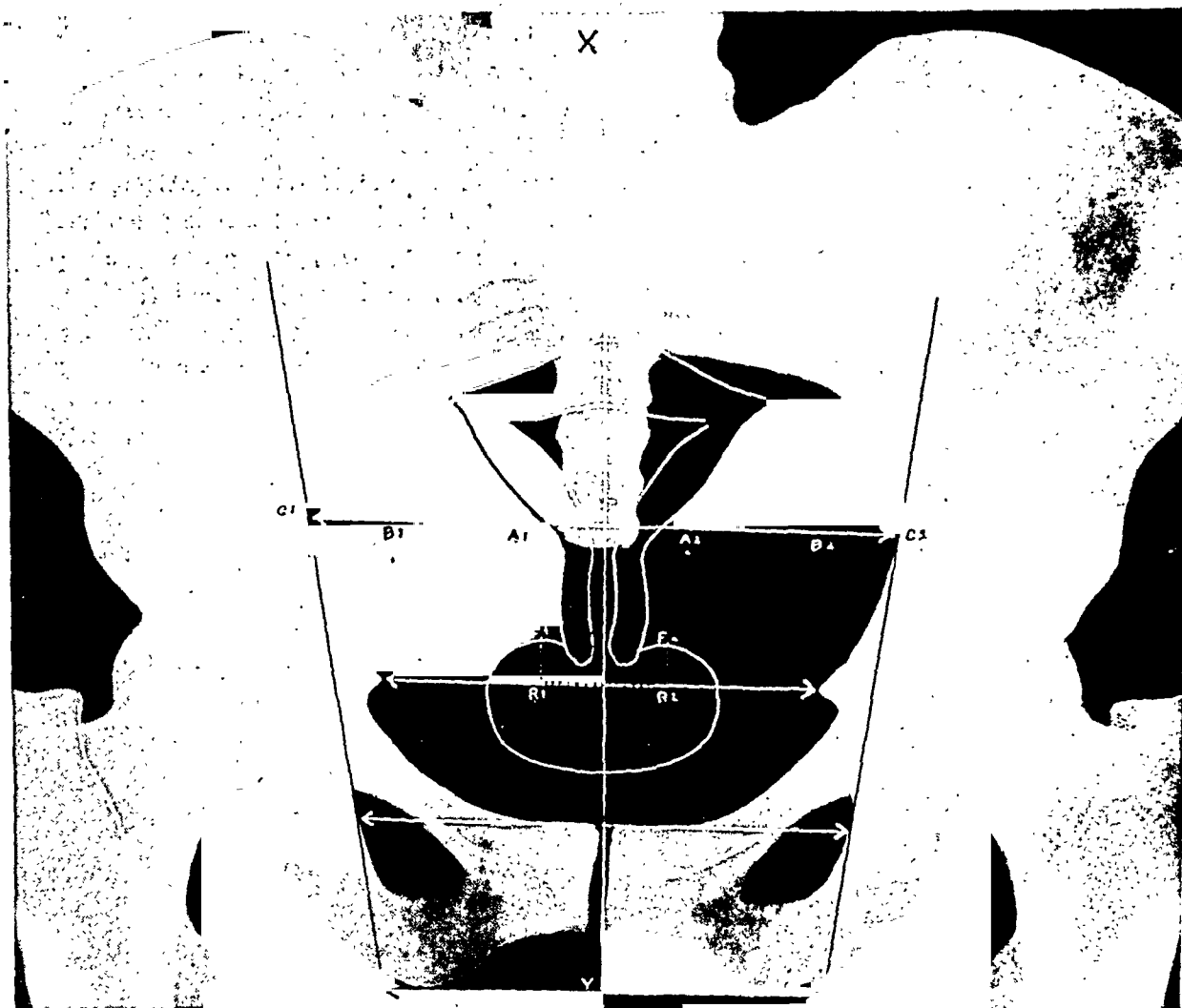


FIG. 1. Showing position of radium sources in vaginal vault designated  $R_1$ ,  $R_2$ ; also Points A, B and C, as described in text.

therapy, two anterior, two posterior, and right and left lateral. This becomes a time-consuming procedure and in order to minimize time and permit the completion of each "cycle" in a working week of five days, we have found a double or "twin cone," as shown in Figure 2, very convenient. This cone is used with as much compression as the patient can tolerate for the anterior portals only and these two 10 by 15 cm. portals are delivered simultaneously at one sitting, the other portals being treated in

the total dose per portal is 1,800 r, the amount which can be delivered at Point C will be 3,150 r. If the dose per portal is carried to 2,400 r the amount delivered at Point C will be 4,190 r. Heavier doses than these will frequently cause undesirably severe skin reactions or the complication of cystitis or proctitis. A very good combination has been found to be 1,800 r on the anterior and posterior portals while the lateral portals are carried up to 2,400 r or higher, the object of this procedure being

to hold back the dosage at Point A (since this can always be carried to any point desired by means of the radium application) and build up the dosage reaching Point C to the highest level the tissues will tolerate.

If, instead of the six portal technique five portals are used, the dose delivered at Point C will be 2,380 r, while if only four portals are used this dose will be further reduced to 2,090 r. Calculations in these tables are prepared from standard isodose and depth dose charts. Therefore, both from the standpoint of total dosage and of better distribution the six portal method seems to offer many advantages. The details are tabulated in Table IV.

*Interval Between Roentgen and Radium Therapy.* As has been previously stated the objective in the administration of the roentgen therapy is to secure as high a dosage at Points B and C as possible with a minimum of injury to sensitive structures. Treatment will be discontinued for any one of the following reasons: (1) the required dosage has been reached; (2) a severe skin reaction is developing which it is undesirable to carry further; (3) proctitis or cystitis is developing of such intensity as to preclude carrying treatment further.

In the presence of either of the two latter it is essential to allow the tissues an interval to recover before proceeding with the ra-

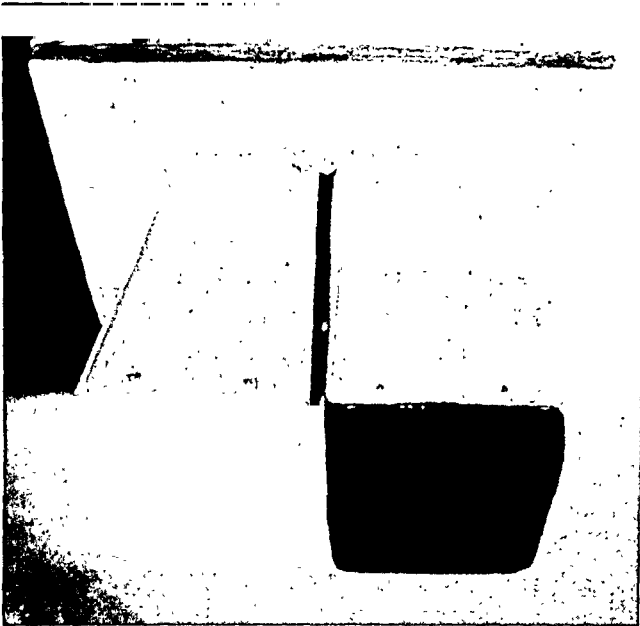


FIG. 2 "Twin cone" by means of which the two anterior portals are treated simultaneously.

dium series. Even if these complications are not present it is important to permit the full biological effect of the roentgen therapy to be reached before proceeding with the radium therapy. The optimum time in our experience is three to four weeks, by which time the tumor cells have undergone very considerable regression, and radium, if applied at this stage, is highly cumulative in its effect so that an effective dose may be delivered with greater certainty than if radium is applied as the first procedure to a

TABLE IV  
DOSAGE DELIVERED BY ROENTGEN THERAPY

No. of Portals	Dosage in Roentgens (in air) per Portal	Point A	Point B	Point C	Point S
4	1,800	2,090	2,050	2,090	1,210
4	2,100	2,430	2,380	2,430	1,410
4	2,400	2,780	2,720	2,780	1,610
5	1,800	2,860	2,580	2,380	2,640
5	2,100	3,330	3,000	2,760	3,070
5	2,400	3,810	3,430	3,160	3,520
6	1,800	2,970	2,970	3,150	1,870
6	2,100	3,460	3,460	3,660	2,180
6	2,400	3,960	3,960	4,190	2,490

bulky, secondarily infected and actively growing neoplasm. If an interval of longer than three or four weeks is permitted several dangers may be encountered:

(1) The maximum degree of regression may have passed and when the radium series is carried out it is applied to a neoplasm already recovering from the effect of the roentgen therapy and again growing rapidly, obviously a most undesirable development to permit.

(2) By reason of the healing of ulceration the tissues about the vaginal vault may undergo too great contracture, thus making the insertion of suitable radium applicators much more difficult or indeed impossible.

(3) Similar contracture may occur in the cervical canal. If the interval is too long the canal may become completely stenosed so that it cannot be located or, if located, cannot be dilated, thus making the intrauterine and intracervical application of radium impossible.

Thus, every effort is made to ensure the carrying out of the radium series in not less than three weeks, and preferably not more than four weeks, following the completion of the roentgen therapy. This rule is departed from only if proctitis or cystitis still persists from the previous therapy.

*Radium Therapy.* In the past there have been several objections to the type of applicators available for the treatment of cervical carcinoma:

(1) *Inflexibility:* This criticism would be applied to metal applicators in which the intrauterine and vaginal radium are combined, i.e. most T-shaped applicators.

(2) *Insecurity:* This is a very serious criticism and applies to corks, colpostats, boxes and almost all multiple applicators held in place by packing. A roentgenogram taken a few hours after the insertion of such applicators is usually very disillusioning if one is greatly concerned about accuracy.

(3) *Danger to Personnel in Handling:* Very few applicators at present in use have been so designed that all handling during loading and most of the manipulation in placing the applicator in position during

treatment may be done by means of forceps.

*Description of New Type Radium Applicator.* In an attempt to overcome some or all of these objections we have designed an applicator which we believe has certain advantages. It consists of two end-pieces, in which the radium is loaded, which are separated from each other by a bridge or spacer. The end-pieces follow the design originally described by Paterson and Parker and conform to the shape of the field of intensity around any radium source. Originally, these were in the form of hollow shells of spun brass, chromium plated, and in the center of each is a platinum-iridium tube of 0.5 mm. wall thickness. This tube may be made of any size or thickness to carry any radium loading which may be decided upon. A cover is provided which is hinged at the mid-point of the bridge so that in loading it can be raised and lowered entirely by instruments. The entire applicator when ready for use is enclosed in a rubber "jacket". The most recent model of this applicator is made of nylon which entirely eliminates all metal parts, is strong and rugged in use and may be sterilized by boiling. Nylon has a molecule composed of carbon, hydrogen and nitrogen all elements having the same atomic numbers as tissue and being free from impurities of high atomic numbers such as frequently occur in rubber.

The bridge or spacer is provided with apertures into which a "fork" is fitted during the manipulation of placing the applicator in position against the cervix. Once in place the applicator is under complete control of the operator and may be placed and held in any position desired. Light packing is inserted merely for the purpose of keeping the tissues out of contact with the instrument. The distal end of the controlling "fork" protrudes from the vaginal orifice and is fastened to a belt which the patient wears throughout the treatment. (A self-retaining catheter is inserted before the belt is finally adjusted and suitable pads are used for protection.)

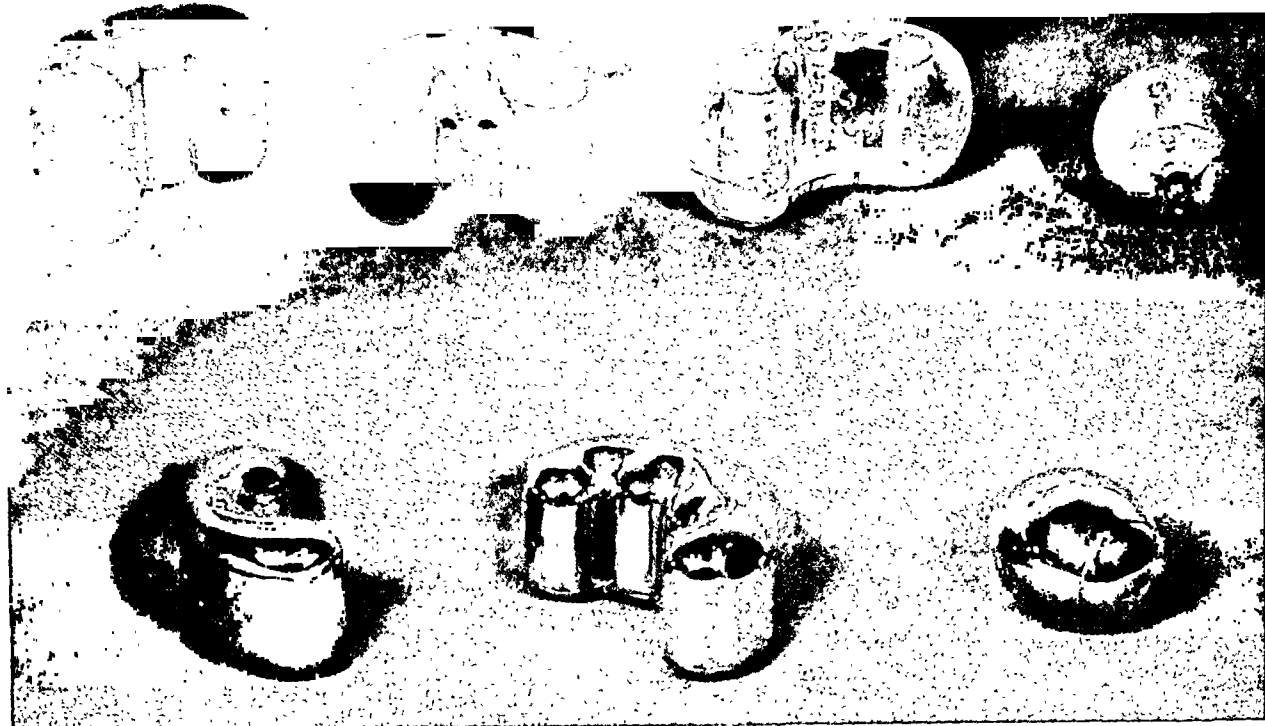


FIG. 3. Top row, four sizes of applicators made of nylon as described in text. Bottom row, metal applicators, spun brass, chromium plated.

Once in place this applicator cannot slip from the position in which it is placed in any direction whatever, either towards either side or, perhaps even more important, cannot either tip over facing the bladder and rectum (which is without doubt the most common cause of cystitis, proctitis and rectovaginal complications), or be partially expelled. Four sizes of the applicator are available and provide amply for the requirements of individual selection (see Fig. 3 and 4).

*Protection of the Rectum.* In the past, one of the most troublesome complications in the treatment of cervical carcinoma has been due to proctitis either during or following the completion of therapy. Measurements made with conventional applicators show that in most cases in which adequate dosage has been delivered to Points A, B and C, the dosage reaching the rectovaginal septum, Point S, has usually been above 5,000 r which is about the tolerance limit of the rectal mucosa. In the applicator here described the rectum is protected by means of a special built-in filter. In the present

applicator the material used for this filter is either gold, platinum or lead, but in the future, as suggested by Mayneord, metallic uranium will be used for this purpose. Owing to its very high atomic weight it is

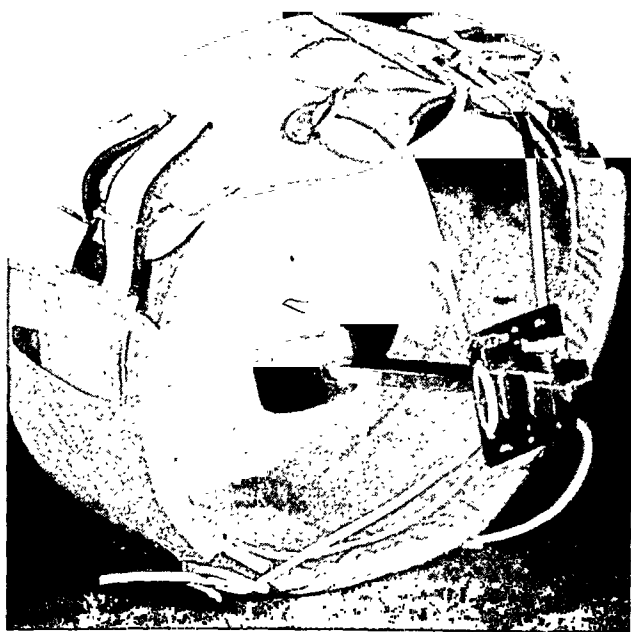


FIG. 4. Applicator ready for use showing "fork" and method of attaching to belt.



especially suitable for this purpose. By this means the intensity of radiation reaching Point S can be reduced 25-30 per cent or even more if desired, thus permitting the use of as high dosages in the parametrium as these tissues will tolerate.

The *intrauterine applicator* is a simple tandem in rubber tubing as, in our experience, this, by reason of its greater flexibility, tends to ease of insertion.

*Dosage.* The dosage in each individual case is determined by a calculation (with apologies to all physicists) which takes into

would carry 40 mg. enclosed in 1 mm. platinum filter, while the vaginal applicator already described would be loaded with 30 mg. in each end and having a filter of 1.5 mm. platinum. Under these conditions 3,500 mg-hr. will be delivered in 87½ hours. Thus the decision to be made is whether this is sufficient or whether either the roentgen dose should be increased or that of the radium. Having reached this decision it would be modified in actual practice only in case the patient fails to tolerate the roentgen therapy well.

TABLE V  
DOSAGE DELIVERED BY RADIUM THERAPY

Type of Applicator	No. of Milligram-Hours	Point A	Point B	Point C	Point S
Intrauterine tandem (40 mg.)	3,000	3,690	780	420	250
	4,000	4,920	1,040	560	320
	4,200	5,170	1,100	590	350
	5,000	6,150	1,300	700	400
Intravaginal (2 × 30 mg.)	3,000	1,050	570	360	1,800
	4,000	1,400	760	480	2,400
	4,200	1,470	800	500	2,500
	5,000	1,750	950	600	3,000

consideration the dose which has already been delivered by means of roentgen therapy.

If the plan of treatment has all been charted prior to the commencement of the roentgen series, the dosage of radium required will be known and will be the amount required to build up the dosage at each of the specified points (A, B and C) to that which is lethal for cancer or to the tolerance limit of tissues at each of these points and will usually be the latter. Some indication as to the degree to which the individual tumor may be expected to respond will have been gained during the roentgen series or at least prior to the administration of the radium, and this will influence the loading of the radium applicators as well as the total dose delivered. In an average case the intrauterine tandem

In the case previously quoted by way of illustration the conditions are as follows:

- (1) A roentgen series using six cycles as previously described together with a radium dose as above will give at Point A, 8,535 r; Point B, 4,730 r; Point C, 4,210 r.
- (2) A roentgen series using eight cycles with the same radium dosage will give: At Point A, 8,700 r; Point B, 5,310 r; Point C, 4,970 r.

If there is evidence that the tumor is resistant and heavier doses are required this would usually be accomplished by increasing the radium to 4,200 mg-hr. which would result in the following: At Point A, 10,600 r; Point B, 5,860 r; Point C, 5,280 r.

This is a very high dose at Point A and should only be undertaken with great caution and such a dose should always be

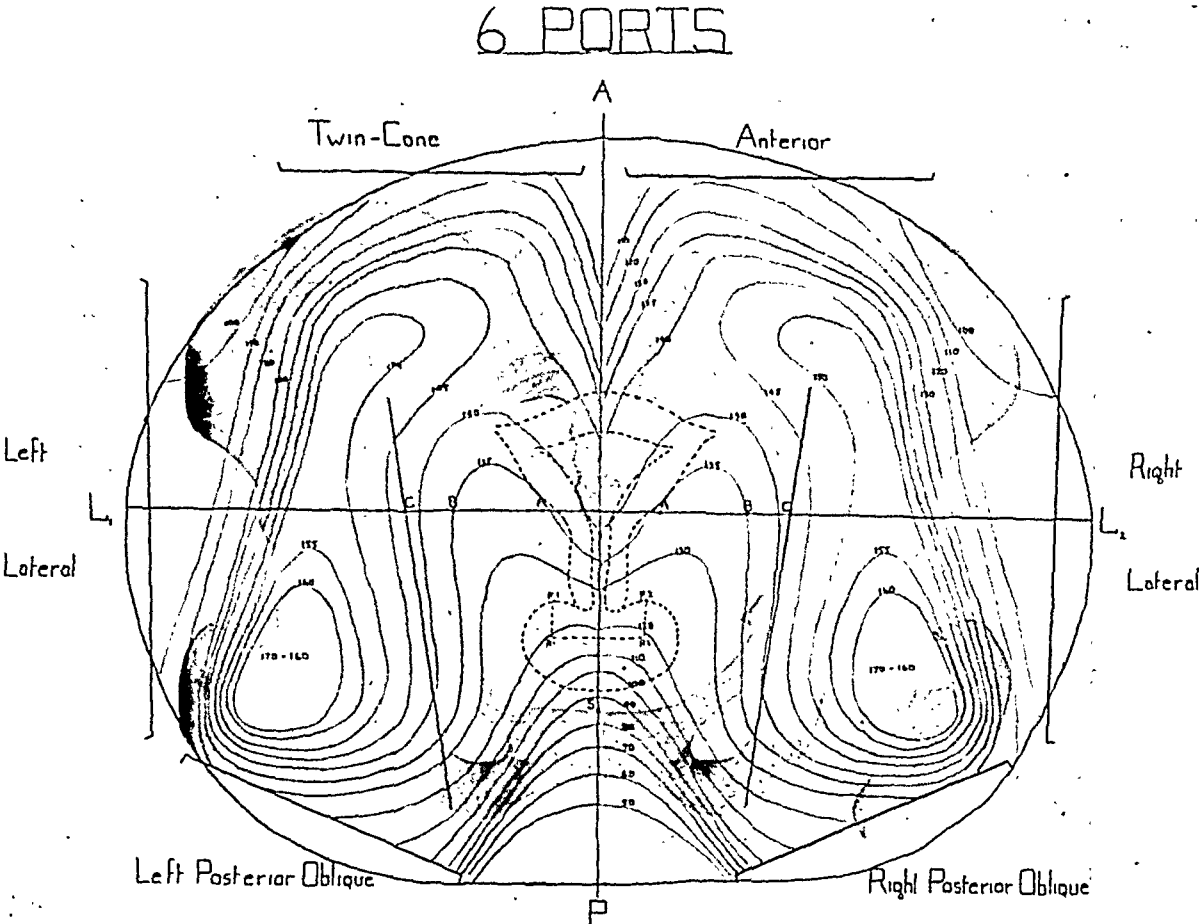


FIG. 5. Isodose chart combining roentgen and radium series.

TABLE VI

DOSAGE DELIVERED BY RADIUM SOURCES R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, IN r PER HOUR

No. of mg. in each source	1 mm. Pt filtration of each source					1.5 mm. Pt filtration of each source					2.0 mm. Pt filtration of each source				
	100	200	300	400	500	100	200	300	400	500	100	200	300	400	500
A	145	290	435	580	725	133	266	399	532	665	118	236	354	472	590
B	68	136	204	272	340	62	124	186	248	310	56	112	168	224	280
C	52	104	156	208	260	44	88	132	176	220	40	80	120	160	200
S	155	310	465	620	775	142	284	426	568	710	127	254	381	508	635

TOTAL DOSAGE DELIVERED IN r BY RADIUM SOURCES R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>

No. of mg-hr. in each source	1 mm. Pt filtration of each source					1.5 mm. Pt filtration of each source					2.0 mm. Pt filtration of each source				
	2,000	4,000	6,000	8,000	10,000	2,000	4,000	6,000	8,000	10,000	2,000	4,000	6,000	8,000	10,000
A	2,900	5,800	8,700	11,600	14,500	2,660	5,320	7,980	10,640	13,300	2,360	4,720	7,080	9,440	11,800
B	1,360	2,720	4,080	5,440	6,800	1,240	2,480	3,720	4,960	6,200	1,120	2,240	3,360	4,480	5,600
C	1,040	2,080	3,120	4,160	5,200	880	1,760	2,640	3,520	4,400	800	1,600	2,400	3,200	4,000
S	3,100	6,200	9,300	12,400	15,500	2,840	5,680	8,520	11,360	14,200	2,540	5,080	7,620	10,160	12,700

The addition of protective filter as described in the article reduces dosage at Point S (rectovaginal septum) 25-30 per cent.

SUMMARY OF HISTORY AND TREATMENT

NAME: Doe, Mrs. John

DIAGNOSIS: February 15, 1939, Carcinoma of Cervix, Stage III.

PATH. REPORT: February 16, 1939, Epidermoid Carcinoma.

TREATMENT: 1. Feb. 16-May 1/39, H.V., 400 KV., pelvis, 6 ports, 2200 r per port.

2. May 25/39, intrauterine radium, 40 mg. tandem, 4200 mg.hrs.  
 intravaginal radium, 2x30 mg. 4200 mg.hrs.

END RESULT: The primary lesion was controlled by the above treatment.

Three years - primary lesion healed; no local recurrence; no extension.

Five years - primary lesion healed; no local recurrence; no extension.

FINAL CONCLUSION: Method used and result satisfactory; no complications.

			1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.	14 yrs.	15 yrs.	
February		Years	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
PRIMARY	Cont.	0	●	●	●	●	●	●	●	●	0	0	0	0	0	0	0	0
	Uncont.	●	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SECONDARY	Cont.	0	●	●	●	●	●	●	●	●	0	0	0	0	0	0	0	0
	Uncont.	●	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
REMOTE META- STASES	Cont.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Uncont.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. & W.		0	●	●	●	●	●	●	●	●	0	0	0	0	0	0	0	0
A.W.D.		●	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.D.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.E.D.		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNTRACED		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Form 601 No. 2-23, 12-45

FIG. 6. Graphic chart used in recording results of treatment. This sheet forms first page of clinic history.

divided preferably into two equal doses one week apart. It has not been our experience that 7,500 r at Point B cannot safely be exceeded, and we have, in a few cases, exceeded 10,000 r with no apparent harm. In general, however, 7,500 to 8,500 r is a safe upper limit.

*Final Total Dosage.* The final totals are added and recorded in the form shown in

Figure 5 and while it is recognized that from the physicists's point of view there are objections to such additions yet in practice the advantages are very great and permit a degree of dosage control not otherwise possible. In a busy department with constantly changing personnel such control is absolutely essential in order to reach and maintain a high technical standard and

avoid serious injuries.

*Use of New Radioactive Materials.* It is now no longer a secret that very shortly new radioactive products will be available having a concentration such that in the space now occupied by a single small radium capsule it will be possible to have a source of radiations equivalent to half a gram or even 1 gram of radium (or indeed more if this should be desirable). Thus a technique may be predicted in which the vaginal applicator here described could be loaded with the equivalent of half a gram in each end and a similar quantity in the fundus of the uterus, omitting an applicator in the cervical canal altogether as suggested by Neary,<sup>3</sup> thus simplifying the dose-distribution equation to that of a triangle with radiation sources at each of its points. It would appear that some such apparatus would go far towards solving the purely physical problem of delivering any desired intensity of radiation at any point within the pelvis. But we shall still be faced with the formidable and fundamental biological difficulty of tissue tolerance which will require the highest possible degree of accuracy and skill which can be brought to bear upon it if great harm is to be avoided.

Certainly if any such quantities of radioactive materials are to be used a much higher degree of accuracy in the placing of radium applicators will be required than has been commonly employed in the past. Accurate planning of dosage will be absolutely essential, while safety of all personnel in the preparation and handling of the applicators will be vital. It is believed that all of these desirable features have been provided for in the applicator described. Calculations using various quantities of radioactive material equivalent to amounts up to 500 mg. of radium and the dosages which would be delivered at each point in the pelvis by such a technique are tabulated in Table VI.

*Graphic Method of Recording Results of Treatment.* The summary sheet and graphic chart in use in this Institute for recording results has been found very convenient and

is reproduced in Figure 6. It provides at a glance most of the essential information required while the graphic chart shows the present status of the case and also indicates whether the follow-up is functioning properly. After the three year period has passed the information contained in the graphic chart is transferred to a master file sheet in which the complete record of all cases in the group is maintained.

#### SUMMARY

The paper undertakes to answer three specific questions relating to the problem of cancer of the uterine cervix.

(1) The first question is a comparison of the best surgical results with the best irradiation results. The evidence favors the latter.

(2) Second, radiotherapy is still making favorable progress and the figures quoted indicate that in the past few years there has been a gain of 20 per cent in Stage I, 15 per cent in Stage II, 5-6 per cent in Stage III, with little or no change in Stage IV. Further progress is still to be expected in the future and means to this end are suggested.

(3) A new type radium applicator is described which appears to have certain advantages in the technical application of radium to the cervix.

(4) Results of treatment at the Toronto General Hospital for the years 1929-1940 are published showing five year survivals in Stage I—74.0 per cent; Stage II—50.5 per cent; Stage III—26.8 per cent; Stage IV—4.9 per cent; all stages—35.6 per cent.

(5) A useful graphic method of recording the results of treatment is presented in Figure 6.

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#### DISCUSSION

DR. CHARLES L. MARTIN, Dallas, Texas. I want first to compliment Dr. Richards on his very ingenious intravaginal radium applicator and also on his excellent five year cure rate. As you know, an absolute figure of 35.6 per cent, and I assume that his figures are absolute, is very good indeed. The radium applicator illustrated in the paper forwarded to me seemed rather large but I have no doubt that he uses others of smaller size in actual practice.

Dr. Richards works in an institution where the entire care of the patient with cancer of the cervix is placed in the hands of one man. He carefully selects the types of radium therapy and roentgen therapy which are to be given and personally oversees every detail of the entire procedure. In my opinion, this may explain much of his success.

It is my impression that he gives much credit to his rather intensive preliminary course of roentgen therapy. In this connection I want to call your attention to the fact that Pitts and Waterman have reported results equally as good as those of Dr. Richards obtained with a radium technique to which no roentgen therapy was added, and the Manchester Clinic has done almost as well with a radium technique to which roentgen therapy was added only in the presence of advanced stages of the disease. Dr. Erskine is just as certain that roentgen therapy alone is the method of choice. Since good results are obtained by such a variety of techniques we have attempted in our own clinic to select the methods which produce the highest number of cures with the lowest number of irradiation sequelae. By placing more emphasis on radium therapy and less on roentgen therapy practically all sequelae have been eliminated without reducing the cure rate.

Our most vexing problem is the correct estimation of tissue dosage. This is due to the fact that we do not have a biological unit which may be used to measure the killing effect of the various types of irradiation on the cancer cell. The biological effect produced by a given number of

gamma roentgens administered in a few hours is quite different from that produced by the same number of gamma roentgens used over a period of five to seven days and certainly one cannot assume that the changes produced by a given number of x-ray roentgens delivered in a period of one month will be at all similar to those produced by the same number of gamma roentgens given in a period of a few days. Therefore, the common practice of adding gamma roentgens and x-ray roentgens in estimating pelvic dosage is not scientifically correct.

Finally, may I say a word about the revival of the Wertheim operation by Dr. Meigs. He has proved that this radical operation may now be carried out in carefully selected cases by a master surgeon with no immediate mortality. However, he has not shown conclusively that the procedure will cure any appreciable number of patients with metastatic lymph nodes situated well out in the pelvis.

I have had a rather extensive experience with metastatic cervical lymph nodes and am convinced that good surgical results are obtained in this region only when a very complete block dissection is carried out in early cases. Dr. Meigs admits that his operation cannot be called a block dissection because he must protect the blood supply of the ureter which lies near the center of the operative field. I must also confess that I am dubious of the curative value of the quantities of radiation that can be safely delivered to the sides of the pelvis in such cases with present day techniques.

There are very few surgeons in this country capable of performing the operation done by Dr. Meigs and since he still advocates radiation therapy for 85 per cent of the patients coming into his own clinic, it is certainly still the method of choice in most of the hospitals and tumor clinics in which cancer of the cervix is treated.

DR. RICHARDS (closing). There are very many questions that time did not permit me to go into fully. Dr. Martin raised a number of these. The first was with regard to the figures. On one of the slides, I tried to show that the figures used were "absolute" figures. Every case was charged against our survival rate, regardless of the cause of death. Also, those which were untraced and all cases seen but not treated, were included. In that respect, the Manchester figures are "net" figures from which all those mentioned have been excluded.

As for the size of the applicators, Dr. Martin

has not seen them, I presume. They are on exhibit in the scientific exhibit. There are four sizes, so that a selection can be made to suit any individual case. He mentioned about the control of the patient. That is extremely important, and I am fortunate in that these patients are on our own ward and under our complete control. We work with the cooperation of a gynecological consultant but we are responsible for all details of the radiation treatment. It is true that the majority of the treatments are carried out by residents who are constantly changing. Partly because of these changes in personnel, a precise technique is extremely important.

Then Dr. Martin spoke about the unwisdom of adding gamma roentgens and roentgens from x-ray therapy. I quite agree with all that and in my paper I apologized to all physicists, but practically speaking it is very convenient and the best we can do until we get a better unit of measurement.

So far as his discussion of surgical methods is concerned, I haven't any quarrel with Meigs or men of his caliber but feel that it certainly would be a retrograde step if all surgeons under-

took the operation described by him. Meigs admits 10 per cent of injuries to the ureter in the cases he has operated upon, although he has had no mortality. I submit that any procedure which permits 10 per cent of serious injury is not one for widespread adoption.

Regarding fractures of the neck of the femur, we have had two; both occurred prior to irradiation. We have had no cases that could be attributed directly as being due to irradiation, although if you will study the chart which is also on file in our exhibit, you will see that there is a "hot-spot" right over the neck of the femur. Nevertheless, the importance of getting extra radiation into the side wall of the pelvis is so great and so essential that we believe six portals with two lateral fields are essential.

Finally, I believe the figures, themselves, are proof as far as there can be proof that it is possible to eradicate and control lymph nodes by irradiation. Otherwise, one could not have such a high percentage of cures in Stage III cases which, by definition, must have involvement of lymph nodes in the pelvis. Otherwise, the classification has been in error.



# ROENTGEN THERAPY IN UTERINE FIBROMYOMA WITHOUT OVARIAN STERILIZATION\*

By GEORGE E. PFAHLER, M.D., Sc.D., LL.D.

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**M**Y objects in the presentation of this paper are (1) to prove that the roentgen rays have a direct action on the fibromyoma; (2) to show that the rays can cause the disappearance of a fibromyoma without affecting the ovaries; (3) to show that the ovarian function and regular menstruation can be maintained during and after roentgen treatment; (4) that a deformed fetus may develop in a patient who has had no form of irradiation previously, and the patient may then bear four healthy children even after irradiation of a fibroid, because the ovaries were protected during the treatment, and (5) that healthy children may be born after patients have had treatment for uterine fibromyoma, even when the ovaries have been included, and in whom there has been temporary amenorrhea.

There will be no attempt to argue for the replacement of myomectomy when such an operation is indicated. The roentgen treatment is indicated, however, when there is a reasonably small, interstitial fibroid, and when the alternative is a hysterectomy.

Fibromyoma of the uterus is probably the most frequent gynecological lesion encountered. Ewing<sup>2</sup> states, "Uterine myoma is the most frequent of all tumors, its occurrence being estimated at 50 per cent of all women over 50 years of age (Klob), and at 20 per cent for those over 35 years. The incidence reaches its acme 38.8 per cent, between the ages of 30 and 40 years (Gusserow). The negro is especially susceptible." This indicates that probably one-third to one-half of women reaching the age of forty have fibromyomas of the uterus of varying sizes. The presence of fibromyoma of the uterus, as Masson<sup>6</sup> has pointed out, does not necessarily mean that

treatment is indicated, for in many cases, the fibromyoma is small and is not producing symptoms.

Roentgen therapy has been accepted as a form of successful treatment of uterine fibromyoma for about forty years. I treated my first patient on account of uterine hemorrhage associated with uterine fibromyoma on January 24, 1906.<sup>7</sup> The first patient was a surgeon who requested this type of treatment, and it was carried out without any interference with the surgeon's routine work or habits of life. She has remained well during these forty years. During these past forty years, thousands of cases of uterine myoma have been treated with success.

The generally accepted opinion regarding roentgen therapy in fibromyoma uteri is that in order to bring about cessation of hemorrhage and shrinkage of the myoma, it is necessary to stop the action of the ovaries, and it has been my opinion that the chief factor in producing therapeutic results in this group of cases is due to the action upon the ovaries, and secondarily upon the myoma itself. In a paper read by invitation before the American Gynecological Society, 1915,<sup>8</sup> I expressed the opinion that the action of the rays is upon the tumors as well as upon the ovaries. I also made the statement that I believed we would find it possible to cause the disappearance of uterine fibromyomas without actually destroying the action of the ovaries.

In a paper read by invitation before the Obstetrical Society of Philadelphia, in 1913,<sup>9</sup> I reported the case of a woman of thirty-four, in whom a fibroid tumor had been completely dissipated by roentgen treatment, and after missing two menstrual periods, normal menstruation had returned

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and had continued during four years up to the time of the report. In that case, no pregnancy had developed but the continuation of normal menstruation led me to believe that such was a possibility. Fränkel,<sup>3</sup> referring to the treatment of young women had seen repeatedly amenorrhea produced for a few months, then the patient became pregnant and gave birth to a perfectly healthy child. Stern<sup>11</sup> in a paper published in 1915, reported 2 cases of pregnancy in young women who had been treated for uterine fibromyoma over a period of time by roentgen therapy. The *first* patient was a young woman who was thirty-two and had been married ten years, had one child eight years of age, and the patient was suffering from multiple fibroids with excessive hemorrhage. Between February and August, 1912, the patient received thirty-four fractional roentgen treatments. At this time, during the treatment, Dr. Brettauer found the patient so much improved that he advised discontinuing treatment. The patient menstruated normally up to November, when menstruation ceased. On July 26, 1913, a baby boy weighing 6 $\frac{3}{4}$  pounds was born. Both the pregnancy and the labor were normal. The *second* case was a young woman who had a uterine fibroid of considerable size, with irregular and profuse menstruation. She had sufficient roentgen treatment to diminish the size of the fibroid, and to produce a temporary amenorrhea. She afterward became pregnant and went through a normal labor, and was delivered of a normal child.

In a letter dated January 28, 1946, in answer to an inquiry by me, Dr. William E. Costolow of Los Angeles Tumor Institute (personal communication), writes: "It has always been my opinion that a good deal of the effects from the irradiation on fibroid is due to a direct action of the rays on the tumor itself, although I realize that this has not been so generally accepted. Certainly, in some of the large multiple fibroids which we have had to treat at times, some of the effects must have been due to the direct action on the tumor itself." This inquiry

was made after reading Costolow's<sup>1</sup> report on the treatment of uterine fibromyomas. Costolow analyzed 986 cases, treated between 1927 and 1937. In this group they had found records of *3 patients who were irradiated and later had normal pregnancies.*

Frances A. Ford,<sup>3</sup> of the Mayo Clinic, Rochester, Minn., says, "Pregnancy with the birth of a normal child has been observed following radium therapy." She refers to Castaño who reported on 250 cases of fibromyomata, treated by irradiation, and 3 of the patients became pregnant following treatment. Ford says, "Of 1013 patients treated with radium at the Mayo Clinic between 1915 and 1925, Stacy found that four women each had a living child. Three others had given birth to dead fetuses; one had had two miscarriages, and one was pregnant at the time of her report. In a series of 741 myomectomies reviewed by Stacy, 33 women later had a viable child, and 11 women two or more children." Unfortunately, Stacy's report and other reports do not indicate just how many patients or what percentage of patients in either group were in the child-bearing period. We all know that the fibromyomata give rise to symptoms, usually after the usual active child-bearing period has passed. It is self-evident that only relatively young women who are in the active child-bearing period would likely become pregnant anyway, and therefore this small number of cases does not form a basis for any percentage value as to the likelihood of pregnancy following irradiation.

Ford continues, "Schiller reports the history of a woman aged 43 who had never been pregnant. Premature menopause was induced by roentgen rays because of excessive bleeding. Definite fibromyomata were present in the uterus. *Six months after treatment, menstruation reappeared once, after which the patient became pregnant and delivered a full-term baby which was normal at observation, 18 months later.*"

Ford, in her paper, refers to 3 patients who gave birth to dead fetuses. There is no record as to whether this treatment was



given to patients who had already become pregnant before or after the irradiation has ceased. It is generally believed that if damage has been done to the ovaries, ova will degenerate before they are expelled from the graafian follicles.<sup>12</sup>

Of the cases reviewed by Ford, 3 of the *surgical* group were under thirty, but in such condition that myomectomy proved to be impracticable. Five of the patients treated by *irradiation* were under thirty; *3 of the 5 had normal pregnancies following radium treatment*, all of these being included among the cases reported by Stacy.

Stacy reports the case of a patient, aged seventy-six, who had passed through the normal menopause at fifty-two, had first noticed the pelvic tumor four years before her treatment at the Mayo Clinic, and during these four years, the growth had been quite rapid. Ford says, "Instances of this type discredit the hypothesis that the growth of fibromyomata is stimulated by an ovarian hormone or interaction of ovarian and uterine tissues." She says, "Ewing mentions sterility as one of the possible causes of fibromyomatous tumors. Among the large number of patients having fibromyomata, Young found sterility in 31 per cent, while for all women sterility was found in about 10 per cent. It is more generally believed that the fibromyomata are a cause of sterility by mechanical irritation or obstruction, rather than a result of it."

Zimmern and Brunet<sup>12</sup> state, "This condition [uterine fibromyoma] affects one-fifth of all women older than 30 years." These authors point out that the effect of irradiation is almost entirely on the ovary; development of the follicle is suppressed so that the corpus luteum is no longer formed and the myomas no longer receive the stimulus of the ovarian hormones concerned with proliferation, congestion and hemorrhage. These authors do not exclude from irradiation tumors larger than a four months pregnancy. They explain, "Some evidence that irradiation affects the fibromyoma directly as well as indirectly is

provided by the regression following irradiation of myomas in women already past the menopause: by continued regression of a myoma despite resumption of menstruation: by the reduction of the tumor without interruption of the menses, and by diminution in size of irradiated myomas occurring in the cervical stumps of women after removal of the uterus and ovaries."

Zimmern and Brunet give the following indications for surgical treatment: "doubtful diagnosis, coexistent infectious complications; necrotic, pedunculated, submucous, or interligamentary tumors; coexistent ovarian cyst or salpingitis; presence of a polyp in the cases in women in the child-bearing age." They irradiate all other ovarian fibromyomas. All others can be treated by irradiation and according to my records, those with intramural myomas in women who are in the child-bearing age.

The clinical record of the following cases are of first importance because of the long period of observation and the clinical history.

CASE I was reported first by McGlinn and myself<sup>10</sup> before the Obstetrical Society of Philadelphia April 5, 1917, and I quote the following history as given by Dr. McGlinn on that occasion:

A primipara, age twenty-four, was first seen May 18, 1915, in consultation with Dr. George Mintzer. She was then five months' pregnant and complained of excruciating pain in the sacral region and aggravated nausea and vomiting. Dr. Mintzer diagnosed the case as one of pelvic tumor complicating pregnancy. On examination, I found a large soft boggy mass filling the hollow of the sacrum, the cervix displaced high in the pelvis, anterior and the uterus enlarged to correspond with five months' pregnancy. The mass posteriorly seemed to be part of the uterus and there was a sharp angulation on the posterior uterine wall between the mass and the cervix. Several days previously I had seen and operated upon a case of incarcerated retro-displaced pregnant uterus which presented the same symptoms and physical signs and which had been mistaken for a pelvic tumor. I, therefore, leaned strongly toward the diagnosis of incarceration in this case. Attempts at reposition of the uterus failed. It was then advised that reposition should be tried under anesthesia and

if this failed reposition should be accomplished by abdominal section.

She was admitted to St. Agnes Hospital and on the following day, May 19, 1915, manual reposition under ether failing, the abdomen was opened. Instead of an incarcerated fundus, we found a myoma, the size of a large orange, growing from the posterior wall of the uterus completely filling the hollow of the sacrum. The tumor was soft and apparently not encapsulated and it was impossible to remove the tumor except by hysterectomy. After consulting with her husband and parents, it was decided not to interfere with pregnancy and to deliver her, if she went to term by Cesarean section if the tumor interfered with normal delivery. Fortunately, she aborted, one week after operation, an acephalic monster. She made an uninterrupted recovery from the operation and miscarriage and left the hospital in three weeks.

She was next seen September 22, 1915. The uterus was anterior and well involuted. The tumor on the posterior wall was only slightly smaller than when last seen. A small fibroid nodule the size of a walnut was also found at the left uterine cornua. This growth was not noticed previously.

The patient was very anxious for children and refused hysterectomy. I then took up the question of x-ray treatment with Dr. George E. Pfahler. Dr. Pfahler was averse to treating the patient on account of her demands that pregnancy should not be interfered with by any treatment we should adopt. Finally after a thorough understanding with the patient, it was decided to attempt to irradiate the tumor and to protect the ovaries as far as possible. Accordingly, I mapped out the exact situation of the tumor for Dr. Pfahler who improvised a special technic for the treatments. No attempt was made to treat the small growth of the fundus of the uterus and the treatments had no effect upon it.

Patient next seen December 30, 1915. Has had three x-ray treatments. Backache better; menses regular, last four days. Mass on posterior wall much reduced in size. No longer fills the culdesac: feels size of small egg.

January 27, 1916. X-ray treatment January 26, 1916. No change in size of mass since last examination. Normal menstrual period two weeks ago.

February 16, 1916: Menstruated normally from February 9 to 14th. Tumor seems slightly smaller.

March 24, 1916: Last normal period February 9 to 14. Three weeks later had slight bloody discharge which lasted two days, had not seen anything since. The uterus is larger than at the last examination, the bulk of enlargement being due to the tumor at the left cornua. The question of possible pregnancy was considered though the patient had been warned to avoid pregnancy until we gave our consent. She admitted having had intercourse but stated that withdrawal was practised.

April 27, 1916. Normal menses on April 7. Tumor smaller.

June 28, 1916. Mass on posterior wall of uterus entirely gone. Tumor still present at left cornua. Advised to resume normal sexual life.

October 25, 1916. Last menstrual period September 8 to 12. No definite signs of pregnancy present. No change in the nodule at the left cornua of uterus. No evidence of original mass in posterior wall of uterus.

March 12, 1917. Last menstrual period September 8 to 12. Felt life about the middle of January. Uterus enlarged to correspond with the sixth month of pregnancy. Diagnosis: Pregnancy at sixth month. Pelvis entirely free. No evidence of original growth on posterior wall of uterus. Nodule at left cornua still present and slightly enlarged.

*Record of Pregnancies after Irradiating the Fibromyoma.* On June 30, 1917, a perfectly healthy baby girl was born but died at fifteen months of age, during the influenza epidemic of 1918. On October 12, 1918, twin boys were born (now aged twenty-eight). One weighed 5 pounds and the other 8 pounds at birth. The larger boy has always remained heavier. The smaller one at the age of twelve developed some lung condition, thought to be early tuberculosis. After about three months of care by a local practitioner, the lungs cleared and he has remained well since. Both twin boys at the age of twenty-eight are well, normal mentally, and are reported to be slightly above the average in mental development. Both boys were first-class scullers. Both boys served in the Army for two years. The larger boy is engaged to be married.

The youngest son was born in 1925, and had served in the Navy three years and seven months at the time of the last report. He is now twenty-one years of age and well. The record, therefore, indicates the birth of four healthy children after irradiation of the uterus, but with protection of the ovaries. One died at the age of fifteen months but from acute infection. The other three served in the Army and Navy.

The mother died of heart disease November 17, 1939. The father had died in 1934.

*Technique.* Because of the fact that uterine fibroids have been successfully treated by means of the roentgen rays after the menopause, and because of the favorable effect of deep roentgen therapy on all types of tumors, Dr. McGlinn and I reasoned that the fibroids in the uterus should be favorably influenced without directing the rays through the ovaries. Fortunately this patient was a favorable case to test this theory. The fibroid was in the median line, and occupied the posterior wall of the

uterus. Its exact position had been determined at the exploratory operation. Granting that the ovaries were in normal position the location of this tumor we reasoned would permit the direction of the rays to the fibroid without passing them through the ovaries. Acting upon this theory, treatment was given entirely through the median area, the ovarian regions being protected. On October 14, 1915, three full erythema doses were given through three different portals of entry in the median space anteriorly, and two similar full doses were given in the median region posterior so directed that they would reach the fibroid in the uterus without reaching the ovaries.

One month after the first course of treatment was given the patient reported that her last menstrual period was the first painless one that she had ever had, and the first in which she did not have to go to bed. She also reported that she could then lie on her side without discomfort. The second course of similar treatment was given on November 10, 1915, three doses anteriorly in the median line, and four doses posteriorly in the median line and through the sciatic notch. The third course of treatment was similarly given on December 8. On January 5, a fourth course of treatment was given, three doses anteriorly and two doses posteriorly. Penetrating rays were used corresponding to No. 9 on the Benoist scale, filtered through 4 mm. of glass and 2 mm. of aluminum, with 40 milliamperes-minutes at a distance of 8 inches, and confining the rays strictly to the area treated.

CASE II. Mrs. H. A. T., aged thirty-seven, was referred to my office by Drs. H. M. Goddard and Collin Foulkrod, July 3, 1924, for roentgen treatment of fibromyomata. Drs. Teller and Foulkrod had advised hysterectomy which the patient had refused. Dr. Teller had reported to Dr. Goddard as follows: "She has a mass of subperitoneal fibroid tumors. They do not give her any symptoms at present, but at her comparatively young age from the size at present they will grow rapidly and will produce symptoms by their size. Remedy is a hysterectomy. Taking into consideration the value of radium and x-ray in these cases, they should only be used where a radical operation would be hazardous to the life of the patient."

Dr. Foulkrod reported that she had consulted him on November 25, 1923, after having missed two periods. She had been previously married

ten years with no pregnancy though every effort had been made toward pregnancy. She had five months in her second marriage. Dr. Foulkrod found her uterus enlarged to the size of a five months pregnancy. She went to her old home in Toledo, Ohio, where she miscarried. On April 7, 1924, Dr. Foulkrod found a fibromyoma in the left cornua the size of a grapefruit, the one in the right cornua was the size of an apple. She refused operation and chose roentgen treatment.

In this case, I used high voltage roentgen treatment 210 kv., 2.5 ma., 32 cm. distance, and a 50 per cent erythema dose, filtered through 0.5 mm. copper. Two such doses were given through each side of the pelvis, one dose in the center anteriorly and two similar doses through each side posteriorly, totalling nine 50 per cent skin erythema doses (measured in air) between July 7 and October 6, 1924. She had only one menstrual period after treatment was begun on July 7, 1924. Amenorrhea occurred from August 24, 1924, until March, 1925.

On December 17, 1925, Dr. Foulkrod found the uterus had been reduced to the size of a two and a half months pregnancy and still retained some of the fibroid nodules. She was not seen again until July, 1926, when she was prepared for delivery, which was a normal primiparous labor. She was delivered by low forceps, because of a rigid perineum. After delivery Dr. Foulkrod was unable to locate any fibroids.

The patient reported to me for examination on March 13, 1928. She was perfectly well and brought a picture of her beautiful sixteen months baby girl, who is now a beautiful young lady, twenty years of age, and is a private secretary.

This case does not belong strictly under the above title, but the miscarriage before irradiation, the complete disappearance of the fibroids with only six months of amenorrhea, and then regular menstruation, and a successful pregnancy and normal delivery at the age of forty, with a normal child, justifies its inclusion.

CASE III. Mrs. M. H., a white woman, aged thirty-five, brought to me by her husband on December 27, 1938, at the request of Dr. Ralph Getelman, because a diagnosis of uterine fibroid had been made by Dr. Roy Mohler and by Dr. Franklin Payne, Professor of Gynecology at the University of Pennsylvania. She had been suffering from excessive menstruation during nineteen years, was anxious for pregnancy, and complained of backache, fatigue, and lack of

"pep." On December 27, 1938, I reported to the husband and sent a copy to Dr. Mohler, who had been her family physician during most of the time, as follows:

I find that she has a small fibroid about the size of an English walnut, located on the right side of the uterus, with the uterus retroflexed. She has had extensive menstruation during the past nineteen years. She is anxious to become pregnant, and has the idea that the fibroid is preventing the pregnancy. This is possible but I am rather doubtful that that is the cause on account of the fact that she has had this excessive menstruation during these nineteen years. If we were only treating the fibroid and not paying any attention to anything else, I would recommend x-ray treatment. However, there is more chance of her becoming pregnant by the removal of this fibroid surgically than if we treated her by irradiation. I believe however that neither you nor she should assume that she will become pregnant immediately even if this fibroid is removed surgically.

The patient and the husband decided upon having roentgen treatment. She returned to me for treatment on March 6, 1939, approximately three months after my first examination. I should add that on a previous occasion she had been taken to the hospital by Dr. Mohler for an operation and was prepared for the operation but she became fearful and would not go through with it. Accordingly treatment was begun on March 6, 1939. These treatments were given anteriorly to the uterus through a field corresponding to the size and location of the uterus and protecting the ovarian region on each side. She was given treatment anteriorly March 6, 10, 15, 1939, using 180 kv., 15 ma., 18 minutes, at a distance of 50 cm., with 0.5 mm., copper filtration, using 60 per cent erythema dose, or 450 r, at each of these treatments. Similar dosage was given posteriorly March 7, 13 and 17, 1939, making a total of 1,350 r, both anteriorly and posteriorly, and one perineal dose was given on November 15, 1939. This represents a total skin dose of 3,150 r, or a total uterine dose of 1,260 r. When examined on January 17, 1940, her menstruation was regular, and pelvic examination showed nothing abnormal. Her pruritus vulvae was gone and she seemed to be well. When examined last on December 6, 1944, she was free from symptoms, uterus normal, cervix normal, no tenderness or abnormalities about the ovarian region. Her menstruation had been regular without interruption, but she had not become pregnant. This was approximately six years after begin-

ning the treatment of her uterine fibroid which was successful in eliminating the fibroid and restoring her to health without interrupting the menstruation.

CASE IV. Mrs. E. G., aged twenty-nine, was referred to me on September 30, 1935, by Dr. Edgar J. Fiestal of Trenton, N. J. Patient had been married nine years and during this time had never been pregnant. She was anxious for pregnancy. Her periods had been very irregular. In the last two periods, she had flooded considerably. The July menstruation lasted fourteen days, in August seventeen days. Gynecological examination showed fibromata of the uterus, and roentgen treatment and radium treatment were advised in preference to surgical intervention. The gynecologist recommended roentgen treatment confined to the uterus because he felt that if he operated, he would have to remove both uterus and ovaries because both ovaries showed a cystic condition, and because of the fact that at her age she was anxious to have children.

Treatments were given with high voltage roentgen rays, using 200 kv., 4 ma., 40 cm. distance, and 0.5 Cu filtration, 225 r given eight times anteriorly, and eight times posteriorly, between September 30 and November 30, 1935. The total skin dosage was 3,600 r or approximately 1,440 r in the uterus. The ovaries were protected.

Her menstruation remained regular. She became pregnant and following the death of her father, she gave birth to a premature "blue" baby boy February 6, 1938, who lived one day. She again became pregnant almost immediately and gave birth to a normal son May 19, 1939, estimated to be one month premature. Labor had been forced because of albuminuria. The son weighed 5 pounds 6 ounces. He is now well at the age of seven. Her menstruation has remained regular ever since the treatment, except during pregnancy.

#### DISCUSSION

This report involves 4 cases in which roentgen therapy was used in the treatment of uterine fibroids of the interstitial type. The ovarian regions were protected by lead and in none of the four was menstruation interrupted. Two of these were followed by a total of six pregnancies. All of the children were normally formed. The first woman

had four healthy children. Three are living today. The oldest two are twenty-eight years of age. The first one died during childhood from causes not related to irradiation (infection). The other three have been in military service and have been normal in every respect.

In the second case, two children were of premature birth, which were believed by the attending physician to be due to accidental causes not related to the irradiation. One is well at the age of seven. Her menstruation is still normal, but further pregnancy has been avoided because of the cardiac disease in the husband.

The third case treated deliberately with protection of the ovaries to avoid sterilization has had no interruption of menstruation, but has not been pregnant during these seven and a half years since roentgen treatment between the ages of thirty-five and forty-three.

A fourth case received some treatment over the ovaries and had an interruption of menstruation for six months. She then became pregnant at the age of thirty-two, and again at thirty-three, and now the child is a healthy girl aged twenty.

In all these cases, the fibroid disappeared completely. The possibility of the development of carcinoma after radiation therapy for fibroid is raised as an objection sometimes. On this point, I quote from Macfarlane:<sup>5</sup> "From our own experience and from this review of the scanty literature of the subject, it is evidence that the possibility of carcinoma developing in the uterus after radium or x-ray treatment is

very remote. This possibility does not contraindicate radium or x-ray treatment of myomatous tumors nor of climacteric bleeding."

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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*Forty-ninth Annual Meeting:* Palmer House, Chicago Ill., Sept. 14-17, 1948.

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*Thirtieth Annual Meeting:* Chicago, Ill., 1948.

# E D I T O R I A L S

## NATIONAL SCIENCE FOUNDATION

IT HAS been more than two years since the publication of the report of the committee headed by Dr. Vannevar Bush entitled "Science, the Endless Frontier". Following that publication and after prolonged study by a sub-committee of the Senate Military Affairs Committee, proposals were made for establishment of a National Science Foundation. During the summer of 1945 Senator Kilgore introduced a bill based on the study of this sub-committee and at the same time Senator Magnuson introduced a bill modeled upon the recommendations of Dr. Bush. Both of these bills provided for establishment of a National Science Foundation within the Federal Government with the following objectives: To support financially and promote basic scientific research, research for the national defense, research for advancement of medicine and health and to establish and support scholarships and fellowships for the development of the latent scientific talent throughout the Nation. There was general agreement at the time both inside and outside Congress upon the general aims but marked disagreement on several features of both bills, especially the method of administration of the proposed Foundation. In the spring of 1946 the differences were somewhat composed and a bipartisan bill called the Kilgore-Magnuson-Saltonstall bill was passed by the Senate early in July with only one amendment, namely, that which eliminated a Division for the Social Sciences. The bill was not passed by the House. The matter was revived in the House of Representatives in the first session of the 80th Congress in the early spring of 1947. In March, the House Committee on Interstate and Foreign Commerce held hearings on four identical bills, H.R. 1815,

H.R. 1830, H.R. 1834 and H.R. 2027, and on a separate bill introduced by Mr. Celler which was essentially a revival of the Kilgore-Magnuson-Saltonstall bill. At the same time the Senate had under consideration a new bill, S. 526, identical in content with the four identical House bills. The most important difference between Mr. Celler's bill and the five identical bills is the method provided for administration of the Foundation. While the Celler bill provides for a single Administrator responsible directly to the President, the five identical bills provide for a Commission of 24 to 48 members who shall elect a Director, the latter to operate under direction of an Executive Committee. One of the identical bills, S. 526, was passed by the Senate on May 20, 1947 and by the House on July 16, 1947. The bill went to the President and was vetoed by him on August 6. Numerous reasons were given for the veto but they all revolved about the methods of organization and administration of the proposed Foundation. The following quotations from the veto message will serve to indicate the President's chief objections to the bill:

... this bill contains provisions which represent such a marked departure from sound principles for the administration of public affairs that I cannot give it my approval. It would, in effect, vest the determination of vital national policies, the expenditure of large public funds and the administration of important governmental functions in a group of individuals who would be essentially private citizens.

... , the organization prescribed in the bill is so unwieldy that there is grave danger that it would impede rather than promote the Government's effort to encourage scientific research.



Under S. 526 the powers of the proposed foundation would be vested in 24 members. . . . These members would be part time officials required to meet only once a year. This group would in turn select biennially from among its 24 members an executive committee of 9 members, and would exercise its powers through the executive committee.

. . .

The foundation would have a chief executive officer, known as the director. He would be appointed by the 9 member executive committee. . . . The power and duties of the director would be prescribed by the executive committee.

. . .

There would be within the foundation a number of divisions. . . . There would be no limit upon the number of divisions which the foundation could establish.

. . .

The foundation would also be empowered to appoint commissions in various fields of research.

. . .

Apart from the conflicts and confusions which would result from this complex organization, the bill would violate basic principles which make for responsible government.

. . .

Full governmental authority and responsibility would be placed in 24 part-time officers whom the President could not effectively hold responsible. . . . Neither could the Director be held responsible by the President for he would be the appointee of the Foundation and would be insulated from the President by two layers of part-time boards. In the case of the divisions and the special commissions, the lack of accountability would be even more aggravated. . . . I am convinced that the long-range interests of scientific research and education will be best served by continuing our efforts to obtain a Science Foundation free from the vital defects of this bill.

I hope that the Congress will reconsider this question and enact such a law early in its next session.

It seems clear from the language of the veto message that a bill acceptable to the President is one which provides for a single administrator responsible directly to the President, such as the bill sponsored by

Mr. Celler at the last session of Congress. Examination of the latter bill, however, shows that its organization into divisions and committees is fully as extensive and complex as in the vetoed bill. Whether it would meet the President's objections if passed is not known.

Study of the testimony presented before the Committee on Interstate and Foreign Commerce of the House of Representatives discloses a general consensus that the most important objectives of a National Science Foundation are basic science research and the training of a large number of new scientists through scholarships and fellowships supported by federal funds. It is obvious, but should be emphasized, that research in basic science depends upon the existence of trained scientists. It follows that among the purposes stated in the various proposed bills, that which provides for establishment of scholarships and fellowships is fundamental. No effective or continuing scientific research can be carried on unless our educational system is organized for continuous training of the individuals who have the qualifications for such training. There was much testimony before the Congressional Committee to show that federal subsidy is necessary to enable a large number of well-qualified High School students to go to college and to further pursue the study of science in post-graduate years. The following quotation from the testimony of Dr. Conant emphasizes this point: "Granted that in terms of the industrial development of the Nation, in terms of public health, and above all in terms of military strength we must find and train our scientific talent, you may ask why a federally supported program of scholarships is required. I wish that all who raise this question could take the time to read the last section of the document entitled 'Science, the Endless Frontier.' The answer to the doubting Thomases is there set forth in detail. . . . The facts presented in that report and in other documents prove convincingly that we have been to a large degree wasting our most valuable national



asset: the innate ability of each new generation."

With only a few exceptions those who testified before the congressional committees strongly supported the view that to accomplish the proposed objectives it is essential to establish a Science Foundation within the Federal Government. In view of the failure to pass legislation to accomplish this, it seems pertinent to inquire whether these objectives can be attained by other means than the establishment of new and elaborate governmental machinery. Is it not possible to so strengthen the many already existing research agencies within the government that basic scientific research will be advanced quite as effectively as through the operation of a Foundation? There are many precedents for appointment of an advisory board of scientists which could make a survey of the work being done in existing agencies and of their personnel and facilities and which could continuously advise concerning the necessity for new projects and the places where they could be worked out to the best advantage. It is admitted by all that most of the basic scientific research work, whether it is initiated by a National Science Foundation or by others, will be carried out in existing university laboratories. Basic research could conceivably be greatly increased by judicious appropriations made by Congress upon the recommendations of such an advisory board as that mentioned above and administered by existing government research departments or by the National Research Council. The latter organization has the machinery and experience to do this very thing. It would also seem feasible for the same agency to administer federal funds in almost any amount for scholarships and fellowships in preparation for scientific careers since it has been doing similar work through grants from private foundations for a long time.

In the field of medicine and health, with which we are concerned, there is special

need for basic research. Medicine is often reproached for its slowness in providing a cure for cancer. The critics point to the rapidity with which the atom bomb was produced when money was furnished in unlimited amounts and scientists organized to do the job. Such critics ignore the fact that the basic research upon which the war-time work depended had been done before the war began. The problem of producing the atom bomb was largely a technological one. The same may be said of radar and of other advances made during the war. The conditions are quite otherwise in providing a cure for cancer. The essential basic facts concerning this disease are not yet known. There is no way of knowing how much basic research must yet be done before we have sufficient knowledge to develop the technique for its cure. It will probably come a little at a time in laboratories scattered over the world. The government has already established its agency for research in cancer within an already existing governmental department, the United States Public Health Service. If there are projects which can be carried out in this field which cannot be done at the National Cancer Institute but require research at some other laboratory, it would seem practicable for the Congress to furnish the funds for such research and to permit the necessary administrative work to be done by the administrative officers of the National Cancer Institute.

The necessity for accelerating basic scientific research is so vital for national defense, for the health of the people and for the progress of industry, and the need for the training of scientists is so urgent, that other methods should be sought at once instead of waiting for the slow processes of legislation to perfect a law which is acceptable to all.

ARTHUR C. CHRISTIE, M.D.

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Washington 6, D. C.



**JAMES MADISON MARTIN**  
1867-1947

**D**R. JAMES MADISON MARTIN died on September 26, 1947, at the age of eighty in Dallas, Texas, after a long illness.

He was born on a farm in Phelps County, Missouri, on December 11, 1867. He disliked farm work and while still a young

man associated himself with a master mechanic who taught him shop work and cabinet making. He maintained an interest in mechanics during his entire life and even in his later years spent much of his spare time in making beautiful pieces of furniture.

Dr. Martin's early education was obtained at the Valparaiso Normal and Business Institute in Indiana and the Vichy Normal and Business Institute in Vichy Springs, Missouri. Although he had no formal instruction in mechanical drawing he taught himself how to draw and became so expert with a pen that he was asked to teach penmanship which was considered an important accomplishment in the early nineties.

His medical degree was obtained at the St. Louis College of Physicians and Surgeons in 1890. In 1892 he became a general practitioner and settled in the small village of Massey, located in the black land belt of Texas. At this location he built a rather elaborate drug store equipped with a laboratory for bacteriological and blood studies, an ambitious undertaking for a physician located in the ranch country twelve miles from a railroad. In 1893 he was married to Emma Auerbach of Edgar Springs, Missouri.

Since country practice was strenuous and not too remunerative he moved to Hillsboro, Texas, in 1901 where he equipped an office. His interest in mechanics induced him to obtain a wall plate and a static machine about which he knew so little that he took an extensive correspondence course in electrophysics. In 1903 one of Pusey's first articles on the treatment of skin cancer with roentgen rays fell into his hands and he elaborated a similar technique which is still considered a very useful procedure.

After attending the annual meeting of the American Roentgen Ray Society in St. Louis in 1904 he became a member. His file on the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY starts with the printed transactions of the Society for the meeting held in 1902 and during most of his professional life he took an active interest in the national radiological societies.

In 1904 he accepted the professorship in "Electro-Therapeutics and X-ray Meth-

ods" in the Dallas Medical College. It was necessary for him to travel sixty miles to Dallas to give each lecture and in 1906 he moved to Dallas where he set up one of the first laboratories in the Southwest devoted exclusively to the use of electrical methods and roentgen rays in medicine. In those early days no suitable textbooks were available and Dr. Martin prepared a mimeographed syllabus for his lecture course, illustrated with blue prints which he made himself. This material was published in book form by the C. V. Mosby Company in 1912 under the title "Practical Electrotherapeutics and X-ray Therapy." The section on skin cancer illustrates results which cannot be excelled today.

Dr. Martin served as Professor of Radiology in the Baylor Medical School for many years and was Professor Emeritus of Radiology in the new Southwestern Medical College at the time of his death. He was a past president of the Texas Radiological Society; the Dallas County Medical Society; the Dallas Southern Clinical Society; the Dallas Doctors' Luncheon Club; the Texas Geographic Society, and the American College of Radiology. He was 32d degree Scottish Rite Mason and a Shriner and a charter member of the Dallas Athletic Club. He was also a Rotarian and a member of the Dallas Bonehead Club. During his entire lifetime he was deeply interested in photography and he made many excellent motion pictures, many of which were in color.

Dr. Martin was a true pioneer in the practice of radiology to which he lent a constant enthusiasm and a degree of energetic support which will not soon be forgotten in the Southwest.

He is survived by one son, Dr. Charles L. Martin, with whom he organized the Martin X-ray and Radium Clinic in Dallas in 1940, and a grandson, Dr. James A. Martin who is now a Lieutenant (JG) in the Navy.

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## FORREST C. SWEARINGEN

1885-1946

DR. FORREST C. SWEARINGEN, a member of the American Roentgen Ray Society since 1921, died on March 24, 1946, at his home in Pomona, California. After being in failing health for several

years, he died from hypertension and uremia.

Dr. Swearingen was born on December 16, 1885, in Sac City, Iowa, and was a member of the class of 1914 at Rush Medi-

cal College. He resided in California from 1915 until his death. He served in the Medical Corps of the United States Army in World War I from August 7, 1918, until February 1, 1919, and was the second commander of the Charles P. Rowe Post of the American Legion. He practiced radiology in Pomona in association with Drs. E. E. Kelly, George D. Brown, and John Staub.

Among the societies and organizations of which Dr. Swearingen was a member are the Los Angeles County Medical Society, the California Medical Association, the

American Medical Association, the Radiological Society of North America, the Pacific Roentgen Society, and the American Cancer Foundation, of which last he was a patron member. He was also a Mason and an Elk, and was past president of the Pomona Rotary Club.

His mother, Mrs. Flora B. Swearingen, his wife, Winifred Morrison Swearingen, and one son, Richard Lee Swearingen, survive him.

RAMSAY SPILLMAN



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary*, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Palmer House, Chicago, Ill., Sept. 14-17, 1948.

#### AMERICAN RADIUM SOCIETY

*Secretary*, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Chicago, Ill., 1948.

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary*, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotel Statler, Boston, Mass., Nov. 30-Dec. 5, 1947.

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary*, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Continental Hotel, Chicago, Ill., June 20, 1948.

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary*, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: Chicago, Ill., June 21-25, 1948.

#### ALABAMA RADIOLOGICAL SOCIETY

*Secretary*, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary*, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Three meetings a year. January, May, November.

#### CHICAGO ROENTGEN SOCIETY

*Secretary*, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary*, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. George L. Sackett, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary*, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

#### DENVER RADIOLOGICAL CLUB

*Secretary*, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary*, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

#### FLORIDA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. A. Beals, St. Luke's Hospital, Jacksonville, Fla. Meets twice yearly, in April preceding annual meeting of Florida Medical Society, and in November.

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary*, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

#### INDIANA ROENTGEN SOCIETY

*Secretary*, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

#### IOWA X-RAY CLUB

*Secretary*, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary*, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary*, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

#### LOUISVILLE RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary*, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

\* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

**NEBRASKA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 p.m. at either Omaha or Lincoln.

**NEW ENGLAND ROENTGEN RAY SOCIETY**

*Secretary*, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

**NEW HAMPSHIRE ROENTGEN RAY SOCIETY**

*Secretary*, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

**NEW YORK ROENTGEN SOCIETY**

*Secretary*, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

**NORTH CAROLINA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

**NORTH DAKOTA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

**OHIO STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland. Meets during meeting of Ohio State Medical Association in Cincinnati, May, 1948.

**OKLAHOMA STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

**OREGON RADIOLOGICAL SOCIETY**

*Secretary*, Dr. William Y. Burton, 242 Medical Arts Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 p.m., Library of University of Oregon Medical School.

**ORLEANS PARISH RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

**PACIFIC NORTHWEST RADIOLOGICAL SOCIETY**

*Secretary*, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

**PACIFIC ROENTGEN SOCIETY**

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

**PENNSYLVANIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual meeting, May 21-22, 1948, Erie, Pa., at Hotel Lawrence.

**PHILADELPHIA ROENTGEN RAY SOCIETY**

*Secretary*, Dr. C. L. Stewart, Jefferson Hospital. Meets, first Thursday of each month, October to May, at 8:00 p.m., in Thomson Hall, College of Physicians.

**PITTSBURGH ROENTGEN SOCIETY**

*Secretary*, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 p.m. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

**RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**

*Secretary*, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

**RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**

*Secretary*, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

**RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.**

*Secretary*, Dr. Moris Horwitz, 2009 Wilshire Blvd., Los Angeles 5, Calif. Meets on second Wednesday of each month at the County Society Building.

**RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**

*Secretary*, Dr. Roy G. Giles, Temple, Texas.

**RADIOLOGICAL SOCIETY OF NEW JERSEY**

*Secretary*, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

**ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 p.m. at Strong Memorial Hospital.

**ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets in Salt Lake City, Utah, 1948.

**ST. LOUIS SOCIETY OF RADIOLOGISTS**

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

**SAN DIEGO ROENTGEN SOCIETY**

*Secretary*, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

**SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**

*Secretary*, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

**SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**

*Secretary*, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

**SHREVEPORT RADIOLOGICAL CLUB**

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 p.m., September to May inclusive.

**SOUTH CAROLINA X-RAY SOCIETY**

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

**TENNESSEE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

**TEXAS RADIOLOGICAL SOCIETY**

*Secretary*, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

**UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**

Meets each Monday evening from September to June, at 7 p.m. at University Hospital.

**UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 p.m., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

**UTAH RADIOLOGICAL CONFERENCE**

*Secretary*, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 p.m., Salt Lake County General Hospital, September to June.

**UTAH STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

**VIRGINIA RADIOLOGICAL SOCIETY**

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St. Richmond, Va. Meets annually in October.

**WASHINGTON STATE RADIOLOGICAL SOCIETY**

*Secretary*, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**

*Secretary*, Dr. Ivan J. Miller, 2000 Van Ness Ave. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

**CUBA**

**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

**MEXICO**

**SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA**  
*General Secretary*, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

**BRITISH EMPIRE**

**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY**  
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

**FACULTY OF RADIOLOGISTS**

*Secretary*, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

**SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**  
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

**CANADIAN ASSOCIATION OF RADIOLOGISTS**

*Honorary Secretary*, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

**SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

**SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES**  
*Secretary*, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

**RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

**SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**  
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

**RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

**SOUTH AMERICA**

**SOCIEDAD ARGENTINA DE RADIOLOGIA**  
*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

**SOCIEDADE BRASILEIRA DE RADIOTERAPIA**

*Secretary*, Dr. Andreilino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

**SOCIEDAD PERUANA DE RADIOLOGIA**

*Secretary*, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

**CONTINENTAL EUROPE****SOCIÉTÉ BELGE DE RADIOLOGIE**

*General Secretary*, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

**ČESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE**

*Secretary*, MUDr. Roman Blána, Praha XII, Korunní 160, Czechoslovakia.

**POLISH SOCIETY OF RADIOLOGY**

First post-war inaugural meeting will be held in Warsaw, May 22 and 23, 1947.

**WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY**

*Secretary*, Dr. L. Zgliczynski, Nowogrodzka 59, Warsaw, Poland. Meets monthly.

**SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**

*Secretary*, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

**ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.**

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

**LENINGRAD ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

**MOSCOW ROENTGEN RAY SOCIETY**

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

**SCANDINAVIAN ROENTGEN SOCIETIES**

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

**SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA**

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

**SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**

*Secretary for French language*, Dr. Babaianz, Geneva.  
*Secretary for German language*, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.



*Isotopes Division Circular E-11*

# AVAILABILITY OF RADIOISOTOPES WITH INCREASED SPECIFIC ACTIVITIES

The Isotopes Division is pleased to announce that Clinton National Laboratory has produced a limited quantity of a number of radioisotopes which have specific activities higher than is available in usual irradiated units listed in our catalog.

will be given on the memoranda accompanying shipments.

The higher specific activity radioisotopes will be distributed in units containing the same quantity of radioactivity as normally present in the standard irradiated units of these isotopes listed in Radioisotopes Catalog and Price List No. 2 of the Isotopes Division. The units of the higher specific activity material will be sold at the same

## *Higher Specific Activity Materials now Available in Limited Quantities*

Isotope	Half-life	All Units . . . . . \$33 Mc/unit	Specific activity Mc/g element	Designation
Cobalt 60	5.3 y	30	250	Item 19, High specific activity
Iron 59	44 d	1.0	0.25	Item 39, "
Iron 55	4 y	*	0.50	
Mercury 203, 205	51.5 d	135	60	Item 47 B, "
Mercury 197	{ 64 h 25 h	‡		
Nickel 59	15 y	1	0.8	Item 51 "
Silver 110	225 d	35	50	Item 72A "
Tantalum 182	117 d	40	830	Item 76 "
Tin 113	100 d	1.0	0.75	Item 3 C "
Antimony 125	2.7 y	*	$\frac{1}{4}$ Mc/gm of Sn†	
Titanium 51	72 d	1	3	Item 84 "
Zinc 65	250 d	15	25	Item 91 "
Zinc 69	13.8 h			

\* The quantity of activity of these radioisotopes present depend upon the age of material.

† Specific activity at the time the irradiated target is removed from the pile.

‡ These activities are present at the time the targets are moved from the pile. Due to their short half-life, little or no activities will be present when units are received.

For a listing of the isotopes concerned, see the table included in the latter part of this announcement. These radioisotopes are all produced by neutron, gamma reaction on suitable pile targets using extended irradiation periods. These irradiated targets have been dissolved in order to facilitate their measurement and distribution in the ordinarily listed quantities of activity listed in Radioisotopes Catalog.<sup>1</sup> Detailed analyses on the solution containing the radioisotopes are not presently available but pertinent information relative to them

<sup>1</sup> Radioisotopes. Catalog and Price List No. 2. Effective March 1, 1947; Revised September, 1947. Distributed by: Isotopes Branch, United States Atomic Energy Commission, P.O. Box E, Oak Ridge, Tennessee.

price as the standard unit. For example, Co 60 is routinely available in the irradiated unit. Item 19 which contains approximately 20 millicuries, cost \$33 per unit and has a specific activity of 30 millicuries per gram of cobalt present in the irradiated target (Co<sub>3</sub>CO<sub>4</sub>). The higher specific activity cobalt will be distributed in units which contain 20 millicuries and cost \$33 per unit but will have a specific activity of 250 millicuries per gram of cobalt. Such a unit should be designated as "Item 19, high specific activity," in all requests, correspondence and orders.

The above table presents the essential information on the now available materials.

Please use Form 313 when requesting allocations of these items.

In addition to the radioiron listed in the above table, another batch of radioiron having a specific activity approximately 1.8 mc. of Fe 59 and 1.5 mc. of Fe 55 per gram of the total iron (at the time the material is removed from the pile) is available from time to time. The latter material will also be distributed in units of 1.0 millicuries of Fe 59 dissolved in a suitable acid and will be sold at \$33 per unit. Since there are two types of higher activity iron, one should designate the activity desired.

All radioiron produced by pile bombardment of natural iron contains both Fe 59 (half-life 44 d) and Fe 55 (half-life 4 y). Due to the difference in the half-lives of the two isotopes, the relative quantities of the two isotopes of iron will materially change with the passage of time from that given in the table and the above paragraph. The Fe 55 content will become relatively higher as its half-life is much longer. If the radioiron is to be used in human beings, the Fe 55 content of the higher activity materials must be determined experimentally and should not be based on calculations using the quantity of Fe 59 activity received. In order to standardize sale prices, the iron units are sold on the Fe 59 content only.

October 24, 1947.

*Isotopes Division Circular E-12*

#### SEPARATED P 32, ITEM S-3, CATALOG

On and after November 19, the solutions containing chemically separated P 32 shipped from Clinton National Laboratory will be in the range of pH 3-5 instead of pH 7-9 as stated in Item S-3 of the Radioisotopes, Catalog and Price List No. 2, revised September, 1947.

This modification is being made to reduce the possibility of adsorption of P 32 on the walls of glass shipping container. Abnormal losses of activity have been noted by some recipients of P 32 shipments and experimental evidence obtained at Clinton Laboratory indicates that the losses were proba-

bly due to the adsorption phenomenon which can be minimized if the solutions containing the P 32 are in an acid state.

The other specifications of Item 3 as listed in the Catalog remain unchanged.

The supply of P 32, Item 3, has been adequate to meet all legitimate demands and can be increased if need for material warrants it.

November 10, 1947

United States Atomic Energy Commission  
Isotopes Division, Oak Ridge Operations  
Oak Ridge, Tennessee

#### GENERAL INFORMATION CONCERNING UNITED STATES PUBLIC HEALTH SERVICE RESEARCH FELLOWSHIPS

The Surgeon General of the United States Public Health Service has been given the authority to establish and maintain research fellowships. These fellowships are intended to promote the training and development of investigators in the field of medicine and related sciences.

#### *Types of Fellowships Awarded—Stipends*

1. A predoctorate research fellowship\* at the Bachelor level is available to qualified applicants who have a Bachelor's Degree. This fellowship carries a stipend of \$1,200 for successful applicants without dependents and \$1,600 per annum for this fellowship awarded to persons with dependents. In addition, the tuition fee is paid by the U. S. Public Health Service.

2. A predoctorate research fellowship\* at the Master level is available to qualified applicants holding a Master's Degree or its equivalent in graduate training. This fellowship carries a stipend, in addition to tuition fees, of \$1,600 for persons without dependents and \$2,000 for persons with dependents.

3. A postdoctorate research fellowship is awarded to qualified persons holding a Doctor's Degree in medical or related fields. This fellowship does not provide tuition fees but carries a stipend of \$3,000 per year for Doctors without dependents and \$3,600 per year for those with

\* These predoctorate fellowships are also granted to medical students who, having completed one or two years of their medical course and contemplating a career in medical research, wish to spend one, two or three additional years in a basic science (biochemistry, physiology, physics, etc.) before completing their studies toward the M.D. degree.

dependents. An increase of \$300 each year is granted to those Doctorate Fellows who are re-appointed.

4. Special research fellowships are awarded to applicants who qualify for a postdoctorate fellowship and in addition have demonstrated outstanding ability or who possess specialized training for a specific problem. This fellowship does not carry a set stipend but is determined in the individual case.

#### *Term of Fellowships*

Fellowships are awarded for one-year periods and may be renewed. Except in unusual circumstances, Postdoctorate Fellows are not reappointed for a third year.

#### *Time of Award of Fellowships*

Fellowship applications are acted upon and fellowship awards are made at approximately three-month intervals.

#### *Vacations*

U. S. Public Health Service Research Fellows may take vacations in accordance with the rules of the institution with which they are working, but not to exceed one month during the tenure of the fellowship; vacations "earned" but not taken during the fellowship cannot be compensated for subsequent to the term of the fellowship appointment.

#### *Travel Allowances*

Travel grants are not made to Fellows except that travel expenses (first-class transportation only) may be granted from the institution of residence or from the home of the Fellow to the institution selected for fellowship training. No allowances will be made for return travel, travel of dependents, or for shipping charges for personal effects and/or household goods.

#### *Concurrent Fellowships*

U. S. Public Health Service fellowships will not be awarded or continued concurrently with the awards of other fellowships except in most unusual circumstances.

#### *Progress Reports*

Progress reports are required at the end of eight months from those Fellows who contemplate applying for reappointment and at the end of the fellowship year from all others. The person under whom the Fellow is working will be requested to submit a report on the Fellow.

#### *Income Tax Exemption*

U. S. Public Health Service has been notified by the Collector of Internal Revenue that "generally where fellowships or scholarships are awarded to individuals in order to enable them to pursue a particular line of research or study, for their improvement and benefit, and no consideration of any kind is given by the recipient in return for such an award, the amount received is considered a gift or gratuity and would not be subject to withholding tax."

#### *Teaching by Fellows*

Fellows are permitted to carry on not more than one hour of teaching or lecture or three hours of laboratory instruction per week during one semester only.

#### *Effective Date for Beginning Fellowships*

Although fellowships are awarded approximately every three months, the effective date for beginning fellowship work can be set at any time to suit the convenience of the successful applicant and the institution in which he will be working.

#### *Application Forms*

Forms of application for a research fellowship may be obtained from the Division of Research Grants and Fellowships, National Institute of Health, Bethesda 14, Maryland.

1. This application form, one copy only, is to be filled out and sent to the Division of Research Grants and Fellowships.

2. The application is to be supported by transcripts of scholastic records and when available by a statement as to relative standing in the class.

3. The application must be supported by letters of recommendation from persons named by the applicant in the application form.

4. The application must be supported by a statement from the department head or other responsible person under whom the fellowship work is to be conducted indicating that satisfactory arrangements have been made with him and with the institution. It is the responsibility of the applicant to make necessary arrangements for the conduct of the proposed research fellowship work and the work may be conducted at any acceptable institution, including governmental research laboratories, such as are provided at the National Institute of Health, National Cancer Institute, etc.

*Support of the U.S. Public Health Service  
Research Fellowship Program*

The support of this program is derived from funds appropriated by the Congress for this purpose to Institutes or Divisions of the U. S. Public Health Service; therefore, fellowships awarded will carry a designation depending upon the funds used to support the fellowship, e.g., National Cancer Institute Special Research Fellow, Division of Mental Hygiene Postdoctorate Research Fellow, National Institute of Health Predoctorate Fellow—Bachelor level, etc.

*Publications*

It is requested that all publications resulting from work carried on by U. S. Public Health Service Research Fellows carry in a footnote

acknowledgment of the fellowship award, and that two reprints of each such report be furnished the Division of Research Grants and Fellowships.

Regardless of the field of endeavor in which the Fellow hopes to conduct his research investigation, all applications should be addressed to the Division of Research Grants and Fellowships, National Institute of Health, Bethesda 14, Maryland, where all applications will first be reviewed by a Central Qualifications Board and subsequently by one of the Specialty Fellowship Boards of the Division or Institute concerned. Similarly, all questions in regard to the Fellowship Program, both by applicants and by Fellows, are to be directed to the Division of Research Grants and Fellowships, which will be pleased to assist in any way possible.



## ROENTGEN DIAGNOSIS

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### NERVOUS SYSTEM

FRIEDL, E. Erweiterung des Wirbelkanales bei Geschwülsten des Rückenmarkes, der Nervenwurzeln and der Rückenmarkshäute. (Dilatation of the spinal canal in tumors of the spinal marrow, the nerve roots and the spinal meninges.) *Radiol. clin.*, Sept., 1946, 15, 275-280.

Dilatations of the spinal canal are not visible in the roentgenogram unless they are very marked and caused by large tumors. These tumors may be gliomata and gliomatous syringomyelia of the cervical column, neurinomata of the nerve roots and cauda or lipomata of the spinal meninges at the lower part of the cord. Neurinomata have a tendency to grow out through the intervertebral foramen. The part of the tumor lying outside the spinal column may grow to the size of a child's head while that inside the canal may not be larger than a hazelnut. These are called hour-glass tumors. They may cause indentation of the posterior surface of the body of the vertebra, destruction of the arches as a result of dilatation of the intervertebral foramen and erosion of the inner surfaces of the arches.

Details of the changes caused by tumors of the different segments of the spinal column are described and illustrated with roentgenograms. —Audrey G. Morgan.

SHENKIN, HENRY A., HORN, ROBERT C., JR., and GRANT, FRANCIS C. Lesions of the spinal epidural space producing cord compression. *Arch. Surg.*, Oct., 1945, 51, 125-146.

This is a presentation of the spinal extradural compressive lesions encountered in a ten year period and taken from the material of the laboratory of neurosurgical pathology at the Hospital of the University of Pennsylvania. This series consisted of 54 cases and comprised, roughly, 30 per cent of the total number of mass lesions of the spinal canal. All patients studied had undergone a laminectomy for symptoms of cord pressure. The pathological material had been reviewed and correlated with the clinical course.

In the older age group, in this series, metastatic carcinoma and multiple myeloma were the most common lesions found. Usually these lesions could be detected roentgenographic methods. In the younger age groups the authors found neuroblastoma and giant cell tumors of the bone was the cause for cord compression. They also found that in the younger age group, the inflammatory processes, such as tuberculous granuloma and epidural abscess, were common. Extradural cysts were also associated with young people. In many of these conditions the clinical course and the roentgenographic findings were particular aids in evaluation of the case.—George W. Chamberlin.

JOSEY, ALLEN I., and MURPHEY, FRANCIS. Ruptured intervertebral disk simulating angina pectoris. *J.A.M.A.*, June 15, 1946, 131, 581-587.

When rupture of a lower cervical intervertebral disk occurs with pressure on the spinal cord or nerve roots, there is usually pain in the neck with radiation to the shoulder, precordium, or down the arm, and it may be associated with weakness or numbness. The pain may be aggravated by coughing or sneezing, or by activity which involves moving the neck. It may occur with merely change in position of the head.

In many cases the presenting symptom is pain in the chest or pain down the arm or both. Sometimes the pain is so severe that other neurological changes are not detected. Since this precordial pain, radiating down the arm, is sometimes associated with activity, coronary occlusion or angina pectoris is thought of.

Within a period of three years the authors saw 30 cases of this type, and they report 7 of these. Detailed histories are given. In one case the pain was brought on by walking a definite distance, and this finding made the surgeon hesitant to operate, despite normal electrocardiographic findings. Relief was obtained by surgical removal of the herniated disk. In another case, precordial pain occurred after successful removal of a herniated disk, and relief of this pain was obtained by neck traction. This finding, combined with other clinical and

laboratory data, established the fact that precordial pain in this patient was associated with recurrence of disk protrusion.

In many cases pressure over the brachial plexus or over the involved nerve root reproduced the pain. Pyelography was done in most cases, and electrocardiograms were obtained on most of the patients. In many, response to glyceryl trinitrate was determined.

The authors emphasize the fact that in any patient believed to have angina pectoris or coronary occlusion who presents any atypical findings, or in whom the suspected diagnosis cannot be substantiated, this syndrome is to be considered. They point out that in the case of a ruptured cervical disk, an operation may not only cure the patient but prevent the possibility of his becoming a hopeless cardiac invalid without necessarily having any heart disease at all.—*E. F. Lang.*

SELANDER, ERIC. Embryonal tumor of the sympathetic nervous system; report of two cases. *Acta radiol.*, 1943, 24, 1-12.

The embryonal tumors of the sympathetic nervous system are relatively rare malignant tumors which arise from the common mother cells (sympathogonia) of the sympathetic ganglionic cells and chromaffin cells or from cells which have become more or less differentiated in one or the other direction. They may be found in any part of the body in which the sympathetic nervous system is represented by cells but they probably arise most frequently from the ganglionated cord or the adrenal medulla. They are most common in children and are sometimes congenital. They metastasize to the liver, the lymph nodes and the bones. These tumors should be kept in mind in the presence of multiple bone changes in children. Clinical diagnosis is generally difficult due to distant metastases appearing before the primary tumor has become demonstrable.

Histopathologically, the tumor resembles small cell sarcoma. Despite considerable radiosensitivity in the primary tumors as well as the metastases, no permanent therapeutic effect has yet been secured due partly to the fact that far-reaching extension has generally already occurred when the patient comes under treatment. Then, too, there is a pronounced tendency toward recurrence.

*Roentgen Picture.* Two types of extension from the tumors arising in the adrenal medulla

are generally cited: (1) in Pepper's type (described in 1901) the metastases are found mainly in the regional lymph nodes and the liver with clinical abdominal tumors as the result; (2) in Hutchinson's cases (described in 1907) the metastases first appear in the skeleton particularly in the orbital walls of the skull which results in exophthalmos and discoloration of the eyelids (often long before the primary tumor can be demonstrated).

In the bones the metastases grow partly in the medulla and partly subperiosteally. From the medulla the process extends to and wears away the cortex which is shown in the roentgenogram as multiple patchy areas of rarefaction which usually are well delimited. The subperiosteal metastases elevate the periosteum which generally reacts with the formation of bone. In advanced cases the line of periosteal ossification is penetrated and spicules appear at right angles to the bony surface. The changes are most commonly found in the shafts of the long bones and the skull. The metastases often develop symmetrically, particularly in the metaphyseal regions of the long bones.—*Mary Frances Vastine.*

#### SKELETAL SYSTEM

EINHORN, NATHAN H., MOORE, JOHN R., and ROWNTREE, LEONARD A. Osteochondrodystrophia deformans (Morquio's disease). *Am. J. Dis. Child.*, Nov., 1946, 72, 536-544.

In 1941, the authors reported 3 cases of osteochondrodystrophia deformans (eccentro-osteochondrodysplasia). In 2 of these the disease was far advanced, and in 1 it was thought to represent an early stage. No detailed report of an autopsy on a patient with osteochondrodystrophia deformans exists in the literature. Recently 1 of these 3 patients died and the authors now report the observations at autopsy in detail.

The patient was a ten year old boy. The roentgenograms showed, on admission to the hospital, a definite disturbance of growth in the epiphyseal centers. The long bones were shorter than normal. There was actual change in shape of some of the other bones, particularly in the bodies of the vertebrae. At the dorsolumbar junction a number of the vertebral bodies were wedge shaped, with resulting kyphosis. In the cervical region there was demineralization and loss of stature, so that the first cervical was located at the level of the foramen magnum

and farther cephalad than normal. These changes resembled those seen in basilar impression of the skull (platybasia).

At autopsy a definite abnormal relationship between the first cervical segment and the base of the skull was demonstrated. This abnormality resulted in pressure on the brain stem and upper part of the cervical portion of the spinal cord, with compression of the latter. The neuromuscular changes observed in the patient were considered secondary to compression of the cord.—*R. S. Bromer.*

HUGHES, B., and GISLASON, G. J. Osteonephropathy; report of two cases. *J. Urol.*, April, 1946, 55, 330-341.

The term osteonephropathy has been suggested for the entity in which bone changes exist in the presence of associated renal disease. This entity has been variously designated previously as renal rickets, renal dwarfism, renal infantilism, renal osteodystrophy, renal hyperparathyroidism and juvenile osteitis fibrosa. The clinical picture is that of a dwarfed and deformed child with diminished renal function, severe acidosis and altered calcium and phosphorus metabolism.

Four hypotheses have been advanced to explain the syndrome: (1) There is a relative or absolute inability of the kidneys to excrete waste endogenous phosphate which is then excreted through the intestinal tract. This leads to formation of insoluble calcium phosphate which prevents calcium absorption. (2) Inability of the diseased urinary tract to excrete phosphates upsets the calcium-phosphorus ratio and this leads to increased parathyroid activity which results in disturbance of calcium metabolism and resultant bone changes. Some authors consider the parathyroid hypertrophy to be primary and the renal condition secondary. (3) Harriss feels that lesions in the pituitary diencephalon area could best explain the clinical picture. Such a lesion could cause urinary tract dilatation and also dwarfism and infantilism. (4) The final theory is that chronic acidosis from long-standing renal insufficiency can cause the bone changes.

Actually most of the cases of osteonephropathy must represent combinations of these various etiological factors.

The authors present an etiological classification of osteonephropathy and describe 2 cases in detail.—*Rolfe M. Harvey.*

HENRY, M. G. Anomalous fusion of the scaphoid and the greater multangular bone. *Arch. Surg.*, May, 1945, 50, 240-241.

The author reports a case of complete bony fusion between the scaphoid and the greater multangular bone. This patient was a man of twenty-five who reported because of a recent injury. The roentgen examination showed the congenital anomaly as well as a fracture of the fused scaphoid. Generally fusion of the carpal bones is associated with synarthrosis of some of the interphalangeal joints. Fusion of carpal or tarsal bones is hereditary and the trait is transmitted according to mendelian law as a dominant factor which is not sex linked. The fact that the greater multangular and the scaphoid are the only two carpal bones which ossify at about the same time suggests that the theory of arrested development as the cause of this anomaly is plausible.—*George W. Chamberlin.*

PECK, Roy I. The treatment of skeletal metastases secondary to carcinoma of the prostate. *J.A.M.A.*, Jan. 6, 1945, 127, 17-19.

Low back pain, with or without sciatic radiation, constitutes a fairly large part of the practice of an orthopedic surgeon. The current wave of becoming "disk conscious," either hidden or otherwise, tends to obscure the fact that there are many other lesions which are equally important in the causation of the low back syndrome. There is a small but definite group of patients over fifty with complaints of sciatica, low back pain and other bone pain which may be secondary to the metastases from carcinoma of the prostate. The metastases from this type of carcinoma are predominantly to the pelvis, sacrum and lumbar spine. These metastases may be either osteoblastic or osteoclastic, the former being by far the more common. As some of these men do not have symptoms referable to the genitourinary system, it is imperative that the rectal examination be included for any man presenting himself with low back pain. This is especially true for men over fifty. Roentgen examination of the lumbar spine and pelvis is, of course, of primary importance in making the diagnosis.

Formerly, treatment of metastases secondary to carcinoma of the prostate was mainly palliative. This included high voltage roentgen therapy, braces to decrease that portion of the pain which occurred with motion and to aid in



preventing that small percentage of cases which went on to pathologic fractures, morphia, section of nerve roots and pain pathways to the spinal cord, and intraspinal injection of absolute alcohol.

Within the last few years a new concept of prostatic carcinoma had been provided. The serum acid phosphatase level is found to be normal in that carcinoma of the prostate which is still confined within the capsule, while it is increased in local and more definitely in skeletal metastases from this neoplasm. It has been shown that the androgen increases serum acid phosphatase, while the estrogen decreases its level. Hence surgical castrations, estrogenic injections or irradiation of the testes would seem to be practical methods of diminishing androgen formation and hence would decrease the serum acid phosphatase level.

There are in the literature about 300 cases of carcinoma of the prostate treated by orchiectomy or administration of estrogen. In about 75 per cent of the cases relief of pain has followed, sometimes as soon as twenty-four to forty-eight hours. There is a gross parallelism in the drop of the serum acid phosphatase level and the clinical improvement. Orchiectomy or treatment with estrogens has not been promoted as a cure but as a physiologic method for the relief of pain, and this benefit may last one or more years. Two cases are cited in each of which carcinoma of the prostate was complicated by extensive pelvic bone metastases. In each patient orchiectomy was followed by symptomatic relief of symptoms and by distinct healing of the metastatic bone lesions. —S. G. Henderson.

GREEN, WILLIAM T. Slipping of the upper femoral epiphysis; diagnostic and therapeutic considerations. *Arch. Surg.*, Jan., 1945, 50, 19-33.

The author reports a group of 26 patients with slipping of the upper femoral epiphysis in thirty-six hips.

The cause of slipped epiphyses is unknown. It occurs most frequently in children between the ages of ten and thirteen years and at a slightly younger age in girls than in boys. Most of the children affected are obese or large in stature. The condition is frequently bilateral. In this series 10 of 26 patients had the disease on both sides.

The patient usually complained of pain and almost always had a limp. The physical exami-

nation disclosed limitation of internal rotation, flexion, and abduction of the involved hip. Limited internal rotation is usually the earliest suggestive physical finding.

The roentgen examination should include anteroposterior and lateral films. The earliest findings are rarefaction of the neck adjacent to the epiphyseal line. There is minimal displacement of the neck anteriorly on the head. This is seen best in the lateral projection. If the slipping is of some duration, irregular new bone formation may be seen filling in the angles between the head and neck of the femur. This presents a mottled appearance of increased density and rarefaction adjacent to the epiphyseal zone.

The author discusses, fairly thoroughly, the different modes of treatment which can be applied to these lesions. His best results were obtained with "traction-spica-traction" treatment and the next best results with the "nailing in situ" method without arthrotomy. He points out that the "traction-spica-traction" method requires approximately one year from the initial treatment to full activity for the patient. Those patients who have the "nailing in situ" return to full activity in a shorter time. In this group, however, there was some danger of involvement of the contralateral hip following the return to activity. It is emphasized, however, that the final evaluation of the result would require a long time follow-up, since many of these patients may develop arthritic changes later in life. —George W. Chamberlin.

MCPHEE, HARRY R., and FRANKLIN, C. MONTANYE. "March fracture" of the fibula in athletes. *J.A.M.A.*, June 15, 1946, 131, 574-576.

For many years athletes at Princeton University have trained in all seasons, in all weather, and on various surfaces. Beginning in 1939, however, a series of 6 "march fractures" of the fibula were observed which exhibited considerable similarity. All occurred in athletes who had been training by running on a board surface, and in a cool atmosphere. In each patient the first symptom was nonincapacitating lameness in the involved leg, which became progressively worse. Early roentgenograms usually showed no abnormality; later, fuzziness of the periosteum at the site of the pain developed. Usually a doughy infiltration and swelling were noted in the soft tissues. A fracture line appeared in the roentgenograms about six to

eight weeks after the onset of symptoms, and its progress was typical of a fracture. With marked regularity the period of disability lasted between ten and fourteen weeks.

In 2 of the cases biopsy was requested by orthopedic surgeons before the appearance of the fracture line, because of suspected tuberculosis or a tumor. In one of the cases the leg was immobilized early, before the appearance of the fracture, but the fracture line developed later, and followed the usual course of fractures. The period of disability was thirteen weeks—five weeks before the appearance of the fracture and eight weeks afterwards.

It has been suggested that in this type of patient the fracture is present but undetected during the first stages of the disease. The authors compare the case histories of their patients to that of a patient with a typical fibular shaft fracture due to direct trauma during a game of lacrosse. The fracture was hairline in type, but weight bearing was not unusually painful. The patient was permitted to play lacrosse during the period of slightly less than four weeks needed for complete healing, with only an aluminum splint for protection.

The contrast between this type of history and the study of the 6 patients with "march fracture" of the fibula leads the authors to suggest the presence of some factor other than a simple fracture in this disease.—*E. F. Lang.*

KNUTSSON, FOLKE. Roentgenological early symptoms and healing phenomena in chronic rheumatic arthritis. *Acta radiol.*, 1943, 24, 121-134.

*Articular decalcification* is described as the initial finding in rheumatoid arthritis. This is caused by the inflammatory hyperemia which occurs in this disease. An increased breadth of the joint space due to exudate may occasionally be recognized roentgenologically. As a rule, the changes are seen first in the bones of the hands and feet. The proximal joint of the little toe seems to be the favorite spot for the initial localization.

*Juxta-articular periostitis* is another early finding. (This observation is original with the author.) The appearance of this periostitis is typical. It consists of a short periosteal thickening extending from the joint for a short distance along the adjacent diaphysis. It is probably caused by an inflammatory irritation which has extended to the periosteum from the joint capsule. Thus this finding is seen to belong to

the florid stage of the arthritis. It disappears as soon as the arthritis loses its more or less acute character. These periostites are usually located in a single toe or finger joint and they extend juxta-articularly on the phalanx or on a metacarpal or metatarsal bone. The author has found them occasionally on the radius and ulna near the wrist.

*Destruction of cartilage leading to a diminution in the joint space and ulceration* constitutes later roentgen findings. Again the little toe is a favorite site. Thus one often finds ulceration on the head of the fifth metatarsal bone as the only roentgenological phenomenon yielded by the examination of several joints.

*The ulceration is transformed from destruction to deformity* when the previously ragged, blurred and indistinct outline of the involved bones takes on an even contour due to their acquisition or a cortical covering.

*Ankylosis* occurs when the reduction of cartilage through the destructive nature of the arthritis has led to complete destruction and the bone surfaces come into direct contact with each other. This complete osseous fusing represents the final healing stage.—*Mary Frances Vastine.*

JANSEN, KNUD F. Calcareous peritendinitis; two cases with localisation to the fingers. *Acta radiol.*, 1943, 24, 285-288.

In its commonest form as painful shoulder, calcareous peritendinitis is an old, well known clinical syndrome first described in 1870 by Duplay under the name of "periarthrite scapulohumerale." By calcareous peritendinitis we understand the deposition of calcareous material in a tendon, peritendinous tissue or joint capsule. This is most frequent in the shoulder region but it has been recognized in other sites especially in the large joints. The author has had occasion to observe 2 cases with localization in the tendons of the finger joints. This localization is extremely rare. In both of the author's cases the condition was found in the left index finger.—*Mary Frances Vastine.*

#### BLOOD AND LYMPH SYSTEM

LYON, R. A., JOHANSMANN, R. J., and DODD, LATHARINE. Anomalous origin of the left coronary artery. *Am. J. Dis. Child.*, Dec., 1946, 72, 675-690.

The cases of 2 infants with anomalous origin of the coronary arteries are reported which bring the total number of reported cases to 20.

In both patients enlargement of the heart, persistent symptoms of respiratory distress and the inversion of the T waves in the first lead or in all leads of the electrocardiogram permitted a tentative clinical diagnosis of the cardiac condition.

In the pathological examination in both cases the important abnormalities found, other than the origin of the left coronary artery from the pulmonary artery, were limited to the left ventricle, where there were endocardial fibrosis, degenerative changes of the myocardium with replacement by fibrous tissue, infarcts in the myocardium and in 1 case persistence of embryonic sinusoids.

In the first case, roentgenographic examination showed an increase in the size of the heart. Lateral roentgenograms with iodized poppyseed oil revealed enlargement of the heart posteriorly. A film of the chest exposed three months later showed clouding of the entire lung field, left side, suggesting accumulation of fluid in the lower portion of that side of the chest. In the second case, enlargement of the heart also was shown in the teleroentgenogram.—*R. S. Bromer.*

CHRISTOPHE, LOUIS. Arteriographie de l'aneurysme carotidocaverneux. (Arteriography of a carotido-cavernous aneurysm.) *Radiol. clin.*, May, 1946, 15, 135-142.

Dandy says that roentgenography can be dispensed with in making a diagnosis of carotido-cavernous aneurysm. But the author describes a case in which arteriography aided in such a diagnosis and believes that it would be useful in making earlier diagnoses when the communication between the vessels is very small.

His case was in a woman of fifty-seven who complained that her eyes had been red for some months. Examination showed dilatation of the conjunctival and ciliary vessels, chemosis, subconjunctival hemorrhage, pupils normal. During the examination a slight pulsation of the eyeballs was noted. There was no exophthalmus. The patient said she had not had any abnormal sound in her head. Nevertheless on the basis of the pulsation of the eyeballs a diagnosis of arteriovenous carotido-cavernous aneurysm was made.

The right common carotid was exposed to permit of cerebral arteriography. The first injection of 10 cc. thorotrast did not give a satisfactory result, nor did the second almost immediately after. With the patient still on the

table a third injection was made and this definitely showed the arteriovenous aneurysm. The author believes that the failure of the first two injections to show the aneurysm must have been due to spasm of the carotid caused by irritation of the vessel walls by the thorotrast.—*Audrey G. Morgan.*

ZUPPINGER, A. Bemerkungen zur Arteriographie. (Remarks on arteriography.) *Radiol. clin.*, March, 1946, 15, 130-133.

There are three important points in roentgenology of the blood vessels: the choice of contrast medium, the technique of making the roentgenograms and the interpretation of the results.

Thorotrast is rarely used on account of its radioactivity and its storage in the endothelial system. Vasoselectan can no longer be obtained. The contrast media used for excretion pyelography must be used. They are very painful and as a result novocain is added. The technique, which still requires improvement, is not discussed.

The chief difficulty in interpretation is the differentiation between arteriosclerosis and endarteritis obliterans. In arteriosclerosis the vessels are usually large and show generalized changes. The course, on account of the elongation caused by the loss of elasticity, is irregularly tortuous to angular; both course and contour are irregular. There are frequently dilatations even in the smaller vessels. If there is an occlusion these small vessels are at first narrow and then show a sudden dilatation.

In endangiitis obliterans the vessels are as a rule small. The changes are localized. In the acute stage the contours are irregular here too, but generally only chronic cases are seen. The course is always curved and there are no angles. If thrombi close the lumen the occlusion may be conical or transverse. There are many collaterals and they do not show angulation. Circumscribed calcification with narrowing of the lumen occurs in endangiitis and generalized calcifications in true arteriosclerosis. Arteriosclerotic and endangiitic changes occur with about equal frequency in diabetic gangrene.

Among 50 arteriograms endangiitic changes were found in 25 and arteriosclerotic changes in 9. Endangiitis causes circulatory disturbances more frequently than arteriosclerosis. If arteriosclerosis causes circulatory disturbances it is only in old age or when there is hypertonia or diabetes.—*Audrey G. Morgan.*

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